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A STUDY OF BURNS AND SCALDS IN CHILDREN

BY

BRENDA MORRISON, M.D.

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The problem of burns and scalds in children has been materially altered during the past five or six years by the fact that human plasma and serum have become available for treatment. This means not only that many lives can now be saved which previously were lost, but also that new problems arise from the survival of children with serious and extensive lesions. In short, resuscitation has so advanced beyond other aspects of therapy that it is possible to keep alive for several weeks or months children who stand little chance of ultimate recovery. The assessment of this chance of recovery and the decision that must be taken at the very beginning as to whether or not resuscitation should be attempted, is often very difficult. It appears that, with only ordinary hospital facilities available, cases with lesions affecting more than 40 per cent. of the body surface do not survive beyond a few weeks; with specially equipped units this could almost certainly be improved upon (Bourdillon and Colebrook, 1946). On the other hand, small children can die from fluid loss when the local lesion is neither deep nor extensive, and in this type of case plasma therapy has altered the outlook completely. There is no need now for any child over the age of one year to die from a lesion involving less than 30 per cent. of the body surface.

The following study was undertaken in the hope of obtaining a better understanding of the problems that arise during the routine hospital treatment of burned and scalded children, and to determine the most reliable criteria for its guidance.

Case Material

Between June, 1943 and March, 1946 a series of thirty-one cases of accidental burns (seventeen cases) and scalds (fourteen cases) were studied by close clinical observation and by simple haematological and biochemical investigations. Table 1 shows age and sex, time of admission to hospital after injury, the nature, extent, and degree of the injuries, and the ultimate outcome in death or recovery.

The injuries occurred in the home except in two cases, that of a girl burned in a bonfire and that of a boy whose clothes caught fire while he was climbing an electric pylon. In sixteen cases the burns were caused by clothing catching fire. A detailed social enquiry was not made, but it was evident that absence of fireguards and lack of space where children can play away from the kitchen hearth were important causal factors, particularly in cold weather. This aspect of the problem has been stressed recently by Colebrook (1946). Nearly all the scalds (twelve out of fourteen) occurred in children under five years, and nearly all the burns (fourteen out of seventeen) in children over five years.

These cases form a selected group in that they all required admission to hospital and showed constitutional disturbance of varying degree. Their ages ranged from one to ten years; half were under five and one-third under three years. The data here considered are more complete for the older than for the younger children as the latter are difficult to study because of lack of co-operation and difficulties of venepuncture. They are, however, liable to severe constitutional disturbance without either very extensive or very deep lesions, and in them prompt and energetic treatment is most important and most rewarding.

The injuries. In estimating the extent of the injuries, the following division of body surface was used:

Head and neck	15 per cent.
Both arms and shoulders	15 per cent.
Trunk (to groin level)	40 per cent.
Both legs and thighs	30 per cent.

In most cases photographs or diagrams were made so that the initial estimate of the extent of the lesions could be checked by later observation.

The lesions are classified according to Dupuytren's seven degrees. This may appear to result in unnecessary subdivision, but it is of value for the prognosis of the lesions and also there is a significant relationship between the subdivisions and the constitutional disturbance. No discrimination is made between burns and scalds, as their difference is one of degree only; in very young children complete skin loss may be caused by boiling water. The following is the classification :

First degree. Erythema, which clears up in two to three days with no more than a scaling of the

TABLE 1
THIRTY-ONE CASES OF ACCIDENTAL BURNS AND SCALDS

Case No.	Age	Sex	Hours after injury on admission	Burn 'B' or Scald 'S'	Extent of lesions (%)	Degree	Died 'D' or recovered 'R'
1	4	F	24	S	15	2, 3	R
2	7	F	72	S	6	3	R
3	6	F	3½	S	15	2, 3	R
4	2	F	2	S	5	3	R
5	1½	M	2	S	12	2, 3	R
6	8	F	3½	B	60	4, 3	D
7	1¾	M	1½	S	33	3, 4	R
8	2	M	2	S	10	3, 4	R
9	1	F	2	S	20	2, 3	R
10	2	F	2	S	20	3	R
11	5	M	½	B	20	4	R
12	2½	F	5	B	20	3, 4	R
13	2	F	2	S	20	2, 3	R
14	10	F	½	B	30	4, 5	R
15	5	F	3½	B	60	4, 3	D
16	8	F	2	B	40	4, 5	D
17	6	M	4	B	75	4, 5	D
18	9	F	1½	B	12	3, 4	R
19	10	M	20	B	7	3, 4	R
20	10	M	1½	B	50	4, 5, 6	D
21	5	F	1	B	15	3, 4	R
22	7	F	1	B	30	3, 4	R
23	3½	F	2	B	30	4, 5	R
24	3¼	M	1	S	12	2, 3	R
25	2¾	M	2	S	20	3	R
26	3	F		B	60	4, 5	D
27	10½	F	1	B	40	4	D
28	5	F	1	B	35	4, 5	R
29	3	M	2½	S	15	3, 4	R
30	2	M	2	S	30	3, 4	R
31	5	F	1	B	25	4, 5	R

stratum corneum of the epidermis, such as is seen after mild sunburning. Apart from the pain produced, the lesion may be disregarded. There is no oozing and no sloughing.

Second degree. Small unbroken blisters or the edges of large blisters. Here there is separation of the superficial epidermal layers from the stratum germinativum by exudate, but the basal layer is intact and healing is complete (in the absence of infection) in ten to fourteen days. A reddening of the skin which fades after a few weeks or months is all that remains. There is no sloughing or scarring. Initial fluid loss from such lesions is not great, and the exudate tends to coagulate after a few hours into a compact jelly.

Third degree. The cuticle is loose and torn or absent; fluid oozes freely from the exposed red area. No white or yellow patches are visible initially, but after several days the lesion comes to have an appearance simulating the strawberry tongue of scarlet fever. There is a thin whitish slough of dead epithelial cells through which the red tops of the exposed vascular dermal papillae are seen. In many areas the whole thickness of the epithelium has been killed, though multiple small islands of it persist between the dermal papillae and around hair follicles and sweat glands. The epithelium, in the absence of infection, will proliferate from these islands and cover the neighbouring areas so that complete healing can occur without grafting. This process takes from three to six weeks. It leaves a rather irregular epithelial surface but no contractures; movement is good.

Fourth degree. There is death of all the epithelium and of more or less of the dermis. Such lesions can be recognized initially by the presence of a white area insensitive to pin prick and from which no oozing occurs. They are surrounded by red oozing areas. Though oozing does not occur from the ischaemic coagulated areas, much fluid exudes from the vessels of the less damaged tissues beneath. Thus, swelling is usually great and the white dry coagulated patch is raised well above the surrounding skin. Sloughing follows, and, depending upon the depth and area of the dead tissue, the time taken for separation is between three and six weeks. It is to be remembered that the presence of a 'purulent' exudate during separation does not necessarily indicate secondary infection. The sloughs, when loose, can be removed with little trauma and have the appearance and texture of chamois leather. After separation, there is left a granulating surface which has no epithelial elements apart from an occasional island growing from a hair follicle or sweat gland. Because inward growth from the edges of the lesion is slow, grafting is required in any sizeable lesion to prevent gross scarring and contracture.

Fifth degree. This is a further stage of the preceding in which the subcutaneous fat is involved.

and separation of the slough occurs through this layer. It can be suspected initially by a parchment or leathery feel of the coagulated skin and by the charred cuticle. Subcutaneous fluid loss is again gross. The sloughs tend to remain drier and harder and to separate earlier and more readily than in the fourth-degree lesions, and the deeper part of the fat is then exposed, often with the remains of coagulated blood vessels in it. This surface granulates and grafting is again essential.

Sixth and seventh degrees. These, which extend to muscle and bone, are seldom seen unless the victim is burned to death. However, electric burns are nearly always very deep and involve muscle frequently and bone quite often. The central core of shrivelled tissue becomes depressed beneath the level of the surrounding less damaged but much swollen tissues.

It is to be emphasized that to the inexpert the appearance of any burn or scald within a few hours of injury is deceptively favourable. It is not until about the tenth day that the area of dead tissue is well defined, and then it is often greatly in excess of what at first seemed likely. But if attention is paid to the details of the lesions, as given above, it is usually possible to foretell from the early stages which areas will later require grafting; in particular it is essential to realize that the presence, immediately after burning, of white patches or mottling in a red area means the complete loss of the epithelium, and that the presence of white insensitive skin inside a red area means that the whole thickness of epidermis and dermis is necrosed and will slough.

Clinical Features Observed

For the first few days observations were made frequently. Blood pressure, pulse or heart rate, and respiration rate were noted every fifteen to thirty minutes for five or six hours, then hourly for a similar period; later three or four times a day and so on as the child's state became stabilized and controlled. Temperature was taken four-hourly, sometimes two-hourly in the initial stages. It was measured in the mouth, or in the rectum if the child was irrational or under three years. Other features closely watched included mental alertness, restlessness, co-operation, pain, thirst, vomiting, sweating, skin colour and temperature, and the degree of oozing from the burned areas. Difficulty was found in measuring fluid intake and output because of vomiting, frequent bed wetting, and unknown loss in the dressings. The urine was examined in all cases.

Blood pressure. For blood pressure estimation a sphygmomanometer cuff with a rubber bag 8·5 by 23 cm. was used for most of the children, and one of 7 by 21 cm. for the babies, these being the correct cuff sizes as determined by Robinow et al. (1939). A series of observations (unpublished) on normal children was made in this department using these cuffs. Repeated readings were taken at five-minute intervals until a steady level was reached; by then the children often had fallen asleep. So estimated, blood pressure varies little throughout childhood and is about 100/70 mm. Hg. The value for the systolic pressure agrees with that found by Robinow and others (1939) using an intra-arterial manometer. The diastolic level is 5 to 10 mm. higher than that given by these writers. In the burned and scalded children, estimates of blood pressure and pulse rate were regarded as significant only when they could be obtained with the child quiet and co-operative; only such readings are included here. In many cases, the blood pressure could not be reliably estimated after the first week or ten days owing to the child's fear of being handled at this stage and consequent crying and struggling.

BLOOD EXAMINATION, ETC. Examination of the blood provides data for estimating the fluid lost from the circulation. Where possible, venous blood samples (heparinized) were taken on admission, six or seven times in the course of the next forty-eight hours, and then daily or every other day for one or more weeks. Such frequent sampling was not always possible since about half the children were under four years of age. Samples were taken for preference from an arm vein, but often the arms were burned. The external jugular vein was frequently used, and less often the internal saphenous vein at the ankle. A drawback of the saphenous vein is that in the presence of even a slight degree of vasoconstriction it yields only very small amounts of blood. The site of sampling was in part determined by the distribution of the burns. Because of the risk of introducing infection it was felt unjustifiable to uncover a burned area for the sake of obtaining a blood sample when the information to be derived from this was not essential for treatment.

In the first part of the series red cell counts and haemoglobin and haematocrit estimations were compared; it soon became evident that the red cell counts were unreliable (i.e. they did not follow the curves of the other two) and they were discarded in the later cases. Haemoglobin seemed reliable when done under uniform conditions (i.e. by the same person using a constant source of light) but some degree of hypochromic anaemia is so common among the children in an industrial area that the significance of a level of, say 90 per cent. (13·6 g.) is difficult to assess. The haematocrit value, on the other hand, tends to be much more constant in the child population. It also has the advantage of easy technique, giving a quick and accurate result in a ward laboratory, which is essential when dealing with an acutely ill child in the middle of the night. (The normal values for all three at different ages were taken from the table compiled by Wintrobe (1942) from collected data. Values for normal blood and plasma volumes were taken from the tables given by Brines et al. (1941).)

Thus the haematocrit proved to be the most valuable single criterion of plasma loss, and in the

later cases it was used exclusively in calculations, although haemoglobin levels were followed in parallel as a check. The amount of plasma loss was calculated as in the following example:

CASE 30. C. R., aged two years :

Normal haematocrit for age = 35 per cent.
Normal blood volume for age = 750 c.cm.
Normal plasma volume for age = 490 c.cm.
Abnormal haematocrit (2½ hours after scalding) = 50 per cent.

Let abnormal blood volume = x c.cm. Then (if total red-cell volume, R., is constant),

$$\frac{35 \times 750}{100} = R = \frac{50 \times x}{100}$$

$$\text{Therefore } x = \frac{35 \times 750}{50} = 525 \text{ c.cm.}$$

Therefore amount of plasma lost over 2½ hours = 750-525 c.cm.
= 225 c.cm.

$$\text{Or } \frac{225 \times 100}{490} = 45 \text{ per cent. of total plasma volume.}$$

If it is assumed that no marked dilution of the blood by tissue fluid occurs, and the rapidity of the loss from the circulation after this type of injury probably justifies the assumption, not only the actual plasma deficiency at the time of the calculation, but the rate of loss can be estimated in this way. The loss was apparently underestimated in some cases where the time elapsing since the accident was more than five or six hours, which suggests that, later, dilution is a significant factor. In very severe cases there is haemolysis of red cells shown by red colouration of the plasma, and in this type of case the loss would again be slightly underestimated. In spite of these drawbacks, as will be shown later, treatment based on such calculations produced more satisfactory results than that guided solely by clinical criteria.

From the same blood samples estimations of blood urea and blood sulphonamide levels were made in the chemical pathology department of the hospital. In a few cases plasma proteins were also estimated by means of the Van Slyke copper sulphate method.

RESULTS OF OBSERVATIONS

Early death. Death occurring during the first hour was not observed in this series, but it does not seem likely that it can be due mainly to the effects of fluid loss as these take several hours to become established (vide infra). Probably other factors are at work such as hyperpyrexia, suffocation by fumes, etc., but these cases do not reach hospital alive and are really of preventive rather than therapeutic interest.

The clinical picture may be divided into three successive phases, namely: (1) fluid loss and concentration of the blood; (2) 'toxaemia'; (3) secondary infection and wasting. (The first phase probably includes both the primary and secondary shock referred to by Wilson et al. (1938), and also some of the features characterizing their 'early toxaemia'; as no tannic acid dressings were used in this series the symptoms which they describe associated with liver necrosis were not seen.)

Fluid Loss and Blood Concentration

The phase of fluid loss and concentration of the blood was studied in detail. It was found that a steady fluid loss persisted for about twenty-four hours, starting immediately or very soon after the injury, and a smaller loss for a further twelve to twenty-four hours; but rate and duration of loss seemed to vary considerably in different patients, other factors being equal. From an analysis of the case records, a composite picture of the physical signs and symptoms of progressive reduction of plasma volume and resulting haemoconcentration was obtained. It is summarized as follows and divided into eight stages in the usual and fairly constant order of appearance:

(1) rising pulse rate;
(2) thirst;
(3) coolness of the nose and extremities and mild restlessness;
(4) pallor, coldness, and cyanosis of the extremities with narrowing of the pulse, commencing drowsiness, and vomiting;
(5) marked restlessness with mental confusion and falling blood pressure;
(6) air hunger;
(7) loss of consciousness;
(8) complete circulatory failure and death.

The later stages were seen only in unresuscitated cases, but from these it appears that death can occur within an hour of the onset of marked restlessness and mental confusion (case 15, M. S.). In small children convulsions may appear at about stage (5) or (6).

Pulse rate. This appeared to be of little value in assessing the severity of the illness during the first forty-eight hours. A steady rise or a steady fall is probably significant of deterioration or improvement, but many children showed gross and irregular fluctuations which bore no obvious relationship to the course of their illness. The rate appeared to be affected by plasma reactions, temperature variations, restlessness, and anaesthesia, as well as by changes in blood concentration.

The width of the peripheral pulse and the ease with which it was felt were of much greater value. As plasma volume decreased the pulse became steadily more difficult to feel until it was impalpable. The ease with which the blood pressure could be measured by the auscultatory method followed closely the width of the pulse. In the later part of the first forty-eight hour period, and after anaesthesia, haemoconcentration was not always accompanied by peripheral vasoconstriction, however, and the fullness of the pulse was then deceptive in judging the patient's condition.

Cyanosis with pallor and coldness of the skin. These are indicative of peripheral vasoconstriction, and their appearance and persistence were of the greatest import. Their absence did not necessarily mean that all was well, but their appearance in fourteen cases corresponded to a loss of 30 to 50 per cent. of the total plasma volume, as shown by a rise in the haematocrit to between 120 and 150 per cent. of the normal value. Although these signs can occur as a result of exposure to cold, they were, almost without exception in the cases studied, associated with serious fluid loss and it would have been dangerous to disregard them.

The blood pressure. During the first two days the blood pressure showed certain characteristic changes which are of interest and of some help in guiding treatment; but it was clear, and can be stated dogmatically, that to wait for a marked fall in blood pressure before commencing intravenous therapy is to take unnecessary risks. In the majority of the children the blood pressure was maintained at normal levels or above, even when the blood volume was dangerously reduced (see fig. 9, J. P.). Hypotension is thus always significant but usually a late sign.

Hypertension, on the other hand, was seen at this stage in twenty-one out of twenty-seven cases in which readings were available. In the majority it appeared only after plasma or serum administration had been commenced, but in two cases it was present on admission (cases 20 and 28). Table 3 shows the highest level reached in each case and the initial level (usually before intravenous therapy). As the children were at this time quite co-operative and often sleeping, it does not seem as though this hypertension could be attributed solely or even mainly to emotional causes. The whole question of hypertension will be discussed more fully later. Even in severe reduction of plasma volume the diastolic pressure could remain above normal, though the systolic had fallen below normal; the narrowing of the pulse pressure in this way may be as significant as a general fall in tension (fig. 9, J. P.).

The mental state. This followed a very characteristic pattern and was related to the injury rather than to the individual personalities of the children. During the first few hours after burning they showed a striking composure and absence of anxiety; they were alert, co-operative, quiet, and appeared to have little or no pain. They allowed themselves to be examined and pricked with little protest. They usually had no complaints but asked repeatedly for drinks. Their behaviour was in marked contrast to the often hysterical state of their parents.

As the picture advanced and vasoconstriction appeared, they often shivered and complained of the cold although the room was quite warm, and asked incessantly for drinks. If they vomited they appeared unconcerned and asked immediately for another drink. About this stage they tended to become drowsy and to sleep if left alone, but very lightly, and were readily disturbed. Restlessness then appeared and was of a characteristically spasmodic type; it took the form of sudden, heaving movements of limbs and body, struggling against restraint, shouting out, throwing off the bedclothes, etc. The spasms passed off as suddenly as they came on and the child was asleep and limp in a few seconds. Drowsiness and mental confusion accompanied the restlessness.

That restlessness of this type was a manifestation of reduced plasma volume was shown by its rapid and striking relief by efficient intravenous therapy. It is a danger signal of the first order and must never be disregarded. Sedatives given at this stage (notably morphine) may mask the gravity of the situation with adverse effects; moreover they are rarely necessary once the fluid loss has been relieved. Smaller children, and usually those less severely injured, were sometimes fretful and resistant to handling in the early stages because of separation from their mothers, but the restlessness was unaccompanied by the other signs of plasma loss and was not spasmodic in character.

Comparison of haematocrit levels. Comparison of the haematocrit levels with the clinical findings described above showed that the haematocrit was a more sensitive index of fluid loss and was considerably raised before clinical illness was obvious. As shown in table 2, there was a fairly close correlation between the severity of the clinical illness and the amount of fluid loss (estimated as described on page 132).

Stages 1, 2, and 3 corresponded with up to 30 per cent. plasma loss, stages 4 and 5 with 30 to 50 per cent. plasma loss, and stage 8 in one case with 69 per cent. plasma loss.

(Fourteen readings with the clinical picture at stages 1, 2, and 3 showed a plasma loss of 8 per cent. to 33 per cent. of the total, with one at 58 per cent.

Six readings between stages 3 and 4, and five at stage 4 showed losses of 23 per cent. to 47 per cent. of the total, and three readings between stages 4 and 5 showed losses of 46 per cent. to 50 per cent. of the total.)

Before stage 4 is reached the signs are not obvious to the inexperienced eye and have always to be looked for, so that up to 30 per cent. of the total plasma volume can be lost without any anxiety being felt concerning the child's condition. This may be interpreted as indicating either that, because a loss of up to 30 per cent. of the total plasma volume is not associated with obvious clinical deterioration it can be disregarded, or that clinical signs are a rather late manifestation of a progressive state, and that the only safe estimate of the seriousness of the fluid loss is obtained by direct haematological examination. When the rapidity with which the haematocrit can rise in even moderately severe cases is allowed for (fig. 10, E. S.), and when it is realized that death can occur probably at any time after

60 per cent. to 70 per cent. of the total plasma has been lost, the conclusion that the latter interpretation is the correct one becomes manifest.

Three children died unresuscitated because of the nature and distribution of the local lesions (deep burns covering 60, 70, and 75 per cent. of the body surface) and they all died between six and seven hours after the accident; one of them (case 15, M. S.) showed no marked restlessness or mental confusion until one hour before death. The haematocrit in heart blood obtained immediately after death in case 26, N. B., was 66 per cent.,

TABLE 2

TO SHOW THE RELATIONSHIP OF THE CLINICAL PICTURE TO THE AMOUNT OF PLASMA LOSS

Case No.	Age	Hours after injury	Stage of clinical picture	Plasma loss %	Range %
10	2	3		22	
22	7	1	1	32	
13	2	6	and	29	
20	10	1½	2	34	
12	2½	6		33	
21	5	1	2–3	8	
31	5	1½		22	8–33
19	10	21		58	(+1 at 58)
8	2	3		26	
10	2	6		31	
14	10	5	3	28	
18	9	2		22	
21	5	2½		19	
24	3¼	4		31	
9	1	3½		23	
14	10	7		44	
20	10	2¾	3–4	46	
23	3½	2+		41	
25	2¾	4		29	
29	3	4		37	23–46
1	4	36		47	
5	1½	19		37	
6	8	4	4	41	
11	5	1+		37	
28	5	1½		46	
27	10½	2		50	
30	2	2½	4–5	46	46–50
16	8	3		47	
26	3	6½	8	71	

giving an estimated plasma loss of about 70 per cent. of the total. Case 28, M. W. (fourth and fifth degree burns of trunk and limbs), who survived and did well, lost 46 per cent. of her total plasma in the first one and a half hours, though her clinical state at that time was only just stage (4) and she did not appear seriously ill.

The following case histories are illustrative of the phase of fluid loss:

Case 3. L. D., aged six years, was admitted to hospital three and a half hours after being scalded. The scalds were mainly second and third degree and covered about 15 per cent. of the body surface (Plate IV, fig. 2a and b). They were dressed under a general anaesthetic (open ether) at six hours with tulle gras and a liberal amount of sulphanilamide powder (exact quantity unknown). When first seen at seven hours she was recovering from the anaesthetic, the face and lips were pink, the skin was dry and the exposed parts cool, the nose cold, but the forehead warm. She was not restless. The pulse felt broad and full but the rate was 180 per minute; blood pressure was 100/70 mm. Hg. Respirations were 22 per minute, deep and occasionally sighing. The haemoglobin was 17·5 g. (photoelectric method) compared with an expected value of 12·5 g.

Eight hours after the accident she was making restless movements of her arms and legs, though still sleeping, and she sighed deeply if disturbed. Her cheeks and lips were slightly cyanosed but her nose was warm. Pulse, respirations, and blood pressure were unchanged. Two and a half hours later she was lying asleep. Breathing was deep and sighing. The nose and exposed arm and hand were cold, and the lips and cheeks were cyanosed. The pulse was impalpable at the wrist, and the blood pressure uncertain because of the faintness of the sounds. The tongue was dry. The pupils were widely dilated but reacted to light. She awoke and appeared dazed, but spoke rationally. During the next thirty minutes she began to turn restlessly in her sleep and to throw off the bedclothes.

Eleven hours after the accident, after a drink of glucose, she vomited coffee-ground material; this was red at first but turned dark brown later and gave a positive Guaiac test. Three-quarters of an hour later the blood pressure was 85/50 mm. Hg., and the pulse 130; 200 c.cm. of plasma were given into an arm vein in twenty minutes; after this she was quieter but still cold and cyanosed. She then became markedly restless, turning right over on to her face with sudden powerful heaving movements, but between the spasms she lay quietly. During a spasm the transfusion needle was displaced from the vein.

At the thirteenth hour the left internal saphenous vein was canalized and 150 c.cm. of plasma were given in thirty minutes, but her nose remained cold and her cheeks cyanosed. The blood pressure was 90/70 mm. Hg. Half an hour later she kicked the canula out of the vein; she was then so restless that it took two people to keep her in bed, and it was almost impossible to hold the leg still. She was very cold and cyanosed and seemed quite unconscious of her struggling. The blood pressure was 90/65 mm. Hg. After some delay the canula was reinserted and the flow started with a two-way syringe.

Fourteen and a half hours after the accident, after having received 500-600 c.cm. plasma (given mostly by two-way syringe because of marked venespasm) she was less cyanosed, the blood pressure was 105/70 and the pulse 120. At the fifteenth hour, after 1,000 c.cm. of plasma had been given, she was sleeping quietly and had had no further restless spasms; her cheeks and lips were pink, and the pulse easy to feel (rate 110). The blood pressure was 110/70 (sounds heard easily). Her nose and exposed hand were still cold, but the respirations were easier and less deep. When awakened she appeared rational and to be taking notice for the first time for several hours. Sixteen and a quarter hours after the accident she was sleeping quietly, but she had been awake and talking sensibly. Her face was flushed and pink, and extremities warm (though her nose was still cool); the pulse was 120 and the blood pressure 130/85. The restlessness had quite gone although no sedative had been given.

Case 5. R. A., aged one and a half years, was admitted with scalds involving about 10 per cent. of the body surface. They were cleansed and dressed under a general anaesthetic at 8.30 p.m. three and a half hours after the accident. He was very restless during the night until given 5 gr. potassium bromide and chloral, when he became very quiet with cold extremities and nose, and was noticed to be cyanosed.

When first seen eighteen hours after the injury he was pallid and cyanosed and his eyes a little sunken. He was sleeping, but awoke when disturbed and cried loudly. His extremities were cold in spite of hot bottles in the bed. He took a small drink but vomited immediately. The blood pressure was 100/65. The haematocrit was 46 per cent. (normal for age, 35 per cent.). At the twentieth hour an attempt to set up an intravenous drip was unsuccessful. An hour and a half later he was very cyanosed and restless in spasms, and very cold. He did not appear conscious, but resisted interference. He stared, and did not blink at a light. The drip was started with a two-way tap, and after 50-60 c.cm. it ran well. He then had several " turns " when his eyes turned up into the corners and the right arm was held stiffly and shaken backwards and forwards. His teeth were clenched and unclenched. He was taking no notice and breathing very noisily, and the whole picture suggested a fit.

By the twenty-fourth hour, after 300 c.cm. of serum, he was greatly improved. He was lying fairly quietly with his eyes closed. The cyanosis had practically gone; the face was still pale but the lips more pink. He felt warm all over and his tongue was moist. The haematocrit had fallen to 32 per cent. By the twenty-seventh hour, after 450 c.cm. of serum, he was warm and flushed and quite rational. The blood pressure was 100/60. The pulse had risen to 180 and respirations to 60. The temperature was 99° F. He made a good recovery.

Case 15. M. S., aged five years, had 60 per cent. of her body surface affected by fourth- and fifth-degree burns when her clothing was completely burned off her. She was not resuscitated. On admission three and a half hours later she lay quietly in bed as though nothing had happened, showed no fear or apprehension, and appeared to have no pain at all. She was quite alert, answered questions, and allowed herself to be turned over and examined without protest. The distribution of the lesions was as shown in the photograph (Plate IV, fig. 3 a and b) and over the major part the skin was completely coagulated, dark brown, dry and leathery, and insensitive to pricks. Beneath the skin there was obvious swelling due to exudation, especially marked over the chest and upper abdominal wall. A band of bright red third-degree burn at the edge was oozing freely. She kept asking for drinks which were vomited immediately. Her extremities were cold and cyanosed, her radial pulse impalpable, and the blood pressure unmeasurable, the latter probably because of the extensive exudation beneath the coagulated skin, the whole arm feeling stiff and rubbery with the tension. The heart sounds were clearly audible over the precordium, and the rate was 120-130. Mouth temperature was 96° F. Only 0·5 c.cm. of blood could be obtained from puncture of the internal saphenous vein at the ankle; then the vein collapsed and could not be refilled. There was haemolysis (plasma red) but the calculated haematocrit was 48 per cent. (Van Slyke sp. gr. method.)

By five hours after injury she was drowsy and becoming unco-operative, but could be roused. Thirst was intense and she vomited everything. She was very cold and cyanosed, her heart sounds were only audible directly over the sternum, her breathing was deep and laboured, and she gasped when talking. The optic fundi showed gross engorgement of the veins with dark blood; the arteries were still red but very narrow. She then became suddenly restless, moving up the bed and from side to side with considerable strength, then for a few moments lying still, apparently unconscious with eyes closed and deep respirations, then waking up again to demand a drink, trying to get out of bed, complaining of the cold, and so on. She was cold all over and extremely cyanosed, with laboured respirations and marked air hunger. Even at this stage the dominant feature was thirst. She was given morphia, gr. 1/8, and rapidly became quiet and unconscious. She died six and a half hours after the accident.

The Phase of ' Toxaemia '

This phase is less well defined and established; it is made up of a group of signs which were related in time and frequency of occurrence, and may be related aetiologically. They were first seen towards the end of the first twenty-four hours after burning, and lasted for varying periods up to six or eight weeks. They did not seem to be attributable either

to fluid loss or to secondary infection, and indeed their rapid appearance and their gradual slow disappearance suggested the action of some chemical 'toxin'. They were seen only in certain cases, usually severe (burns and scalds), but some of the worst cases did not show them. They are: (a) sustained pyrexia; (b) increased depth and rate of respiration; (c) moderate, sustained hypertension; (d) drowsiness and signs of increased intracranial tension, with or without convulsions.

Pyrexia and respiration rate. The first two (a) and (b) were usually associated and it is possible that the hyperventilation was a direct effect of the pyrexia. The temperature showed a characteristic pattern, rising steeply to reach 103° to 105° F. at the end of the first twenty-four hours, then falling very slowly to normal over a period of weeks. During this time a moderate swing within a range of 2-3° F. was present, but the general curve was remarkably steady. It differed from the pyrexia of secondary infection by the absence of marked irregular fluctuations and by its much earlier onset. Fig. 11, C. R., shows its character well. The phenomenon was seen in twelve cases to a varying degree (numbers 5, 7, 10, 16, 18, 21, 22, 23, 24, 25, 27, 28, and 30). They were all severe, ten burns and three scalds, but the latter showed considerable sloughing. In eight cases the pyrexia was associated with hypertension.

Hypertension. Hypertension (c) during plasma or serum administration was seen in twenty-two cases out of twenty-seven where readings were obtained. In fourteen of these, and in one case where no intravenous fluid was given, the hypertension was continued for varying periods up to several weeks after the resuscitation period. The height in each case is shown in table 3. As has already been stated, great care was taken to obtain readings at rest, and if the child was unco-operative readings were discarded. For this reason the duration of the hypertension in most of the cases is not known. During the third and fourth weeks the children became so afraid of being handled that the investigation had to be given up. Fig. 12, C. R., shows a typical course so far as it could be followed. Although the hypertension was most marked in cases where there was much sloughing, it was not an essential accompaniment of sloughing, nor did it subside as soon as the sloughs had separated. Its occurrence was not directly associated with depth and severity of lesion, for it was quite absent in cases 9, 10, and 12 (all 20 per cent. in extent) and confined to the resuscitation period in cases 11, 18, 29, and 31 (among which were one 20 per cent. and one 25 per cent. deep burn).

It seemed that there were at least three factors in the production of hypertension, reaction to plasma or serum given intravenously (this varying with the rate of administration), some unknown mechanism co-existing with sloughing of dead tissue but outlasting it, and an individual (presumably constitutional) liability. The latter was very definite and raises the interesting possibility of a connexion with the essential hypertension of adult life.

Drowsiness. The fourth manifestation (d), namely drowsiness and signs of increased intracranial pressure, was present in six cases (numbers 6, 7, 16, 20, 22, and 27). All these showed the typical sustained pyrexia and all showed hypertension in the resuscitation period and later if they survived (with the exception of case 7, in which no readings were obtained: which is unfortunate as the picture in this case was very striking). They were all very severe cases, five deep burns and one bad scald, and all received intravenous plasma or serum.

The onset of the cerebral signs was fairly sudden, with loss of consciousness occurring between nineteen and thirty-three hours from the accident, but preceded by drowsiness and a tendency to sleep for several hours. Periods of apparent coma, with stertorous breathing and lack of response to painful stimuli, alternated with lucid intervals or restless delirium; the depth of unconsciousness often showed marked and rapid fluctuations. Muscular rigidity and twitchings were seen, and in two cases epileptic convulsions. Cerebral oedema was considered to be the probable explanation of these phenomena. Lumbar puncture in two cases showed a high cerebrospinal fluid pressure (250 mm. and 360 mm.+ of cerebrospinal fluid) and in cases 6 and 20 (dying after five days and twenty-two hours respectively) necropsy revealed evidence of oedema of the brain; it was also seen at necropsy in cases 15 and 17, who died at six or seven hours without resuscitation. It is noteworthy that at the time of onset of the nervous symptoms all the cases showed a haematocrit value still above normal, and three showed clinical signs of reduced plasma volume; it does not seem likely, therefore, that the oedema could be attributed to overadministration of intravenous fluid. On the contrary its occurrence in cases where the circulation was unsatisfactory suggests that cerebral anoxia from undertransfusion may possibly be a factor in causation.

The duration of these nervous signs was usually only two or three days, and in no case exceeded ten days, thus differing from the pyrexia and hypertension.

Summaries of case histories illustrating the nervous phenomena are given below, and case 7 is described more fully.

Case 6. C. N., aged eight years, had 60 per cent. deep burns. This girl showed marked concentration of the blood on admission four hours after burning, but responded to intravenous therapy and after twelve hours was alert, rational, and co-operative. She became rather drowsy during the next twelve hours, then suddenly restless and irrational at the twenty-third hour. She was mentally confused and incontinent of urine during

TABLE 3

HYPERTENSION DURING AND AFTER INTRAVENOUS THERAPY, AND ITS RELATIONSHIP TO TYPE OF LESION AND TO CEREBRAL SIGNS AND PYREXIA

Case No.	Burn or Scald	% body surface involved	Range of B.P. during intravenous therapy	Days after end of i.v. therapy	B.P.	Cerebral signs	Sustained pyrexia
1	S	15	110/75–180/115	1½ 2	145/105 130/85		
2	S	6	No. I.V. Therapy	7	125/85		
3	S	15	85/50–130/85	½ 18	130/95 130/95		
4	S	5	No Hypertension	No Hypertension			
5	S	12	90/50–120/65	No Hypertension			
6	B	60	100/75–140/95	No Hypertension		++	++
8	S	10	105/70–120/75	5	115/60		
9	S	20	No Hypertension	No Hypertension			
10	S	20	No Hypertension	No Hypertension			+
11	B	20	100/60–140/75	No Hypertension			
12	B	20	No Hypertension	No Hypertension			
13	S	20	110/55–145/100	No Readings			
14	B	30	75/50–120/80	3	125/80		
16	B	40	70/55–160/125	2 13 42	140/70 175/85 135/95	+++	++
18	B	12	120/80–135/90	No Hypertension			+
19	B	7	88/65–120/80	11	115/80		
20	B	50	145/110–110/85	Died		+++	
21	B	15	115/60–135/100	3 10	135/80 105/70		+
*22	B	30	160/105–190/106	2 12 28	140/100 150/85 150/95	++	++
23	B	30	90/65–140/80	2 18	130/65 135/75		+
24	S	12	90/64–130/80	No Readings			
25	S	20	110/40–140/90	6	125/75		(+)
27	B	40	Unobtainable—150/100	2 5 11 28 42	120/75 150/85 135/95 130/110 135/95	++	
28	B	35	110/85–135/85	1 21 42	135/95 135/105 130/95		+
29	S	15	No Hypertension	No Hypertension			++
30	S	30	115/65–135/95	2 3 14	130/85 160/100 130/80		
31	B	25	105/70–115/80	1 11	115/75 95/55		

* Leg readings.

the night, but at the forty-second hour was rational and quiet. Forty-six hours after injury she had a sudden screaming attack, throwing her arms and legs about and breathing deeply. Thereafter she became progressively more unreasonable and eventually comatose. She developed bronchopneumonia and died on the fifth day.

Case 16. M. H., aged eight years, had 40 per cent. deep burns and showed marked haemoconcentration which was controlled with difficulty. She remained mentally clear, but dozed frequently during the first twenty-four hours. Her breathing then became noisy, and by the twenty-fifth hour she was comatose, unrousable, and her mouth twitching. Lumbar puncture two and a half hours later showed a cerebrospinal fluid pressure of 250 mm. After 10 c.cm. of cerebrospinal fluid were removed slowly she roused and spoke a few words. Periods of coma with lucid intervals continued. Two and a half days after the accident she was normally conscious and alert. She died at six weeks from secondary infection and septic bronchopneumonia.

Case 20. J. P., aged ten years, had 50 per cent. deep burns, and moderate plasma loss on admission one and a half hours after injury, but the haematocrit rose steeply during the next hour. His blood pressure was 145/100 mm. Hg. before intravenous therapy. Resuscitation with intravenous plasma and saline was started and was maintained until death, but he was given insufficient quantities of fluid and his circulation was unsatisfactory for many hours before he died (fig. 9). He became drowsy and difficult to rouse, but when awake he was rational and asking for drinks. At the nineteenth hour he suddenly took a convulsion which lasted for five minutes; he recovered consciousness again but his respirations were deep and heavy. Three and a half hours later he was again mentally confused and resistant to handling and appeared about to take another convulsion. Lumbar puncture showed a pressure of 360 mm. of cerebrospinal fluid ; between 6 and 7 c.cm. were removed slowly. Breathing ceased suddenly, was restarted again with artificial respiration, then ceased again, and he died twenty-three hours after his injury. At necropsy the brain showed a well marked pressure cone.

Case 22. C. S., aged seven years, had 30 per cent. deep burns. Intravenous therapy was started early but the haemoconcentration was only partially relieved and she was restless with a rapid pulse all night. After twenty-three hours she became semiconscious, struggling when touched and having restless spasms. She remained drowsy, irrational, and unco-operative for a further twenty-four hours, then quickly recovered normal mental clarity. She subsequently made a good recovery.

Case 27. S. C., aged ten and a half years, had 40 per cent. deep burns. The blood showed marked concentration on admission one and a half hours after injury. She was given intravenous plasma, but the amount was inadequate and the haematocrit remained well above normal (fig. 15) but she was alert, quiet, and co-operative. At the twenty-eighth hour she complained of feeling unwell, wanted to lie down, and her temperature rose to 104° F. An hour later she suddenly became quite unconscious and unrousable and was breathing deeply. Her pupils were very small. Fifteen minutes later she was rousable but very drowsy and complaining of headache. For some hours she remained very drowsy with alternating rational and irrational responses, but she was never comatose. She was mentally clear by forty-eight hours and then improved steadily; however, she died with wasting and bronchopneumonia after eight weeks.

Case 7. A. B., aged one and three-quarters years, suffered 30 per cent. third-degree scalds. He was admitted at one and a half hours later and already showed coldness and cyanosis of the extremities and facial pallor. He was excited and restless and screamed when touched. There was an estimated loss of 30 per cent. of plasma volume. An intravenous drip was commenced one hour after admission, and 100 c.cm. serum were given quickly; after 200 c.cm. he became quiet and fell asleep, and after 350 c.cm. (at four hours) the vasoconstriction had gone. At twelve hours he was quiet, alert, and warm, but cyanosed, and the estimated plasma deficiency was still 30 per cent. of the total (after 700 c.cm. serum intravenously, equivalent to 120 per cent. of normal plasma volume). By fourteen and a half hours he was restless and delirious with marked cyanosis, though his skin was warm and his temperature was 104° F. He slept a good deal. At twenty-two hours he took a convulsion with tonic and clonic spasms. Shortly after this his blood showed some concentration but less than at twelve hours. His blood pressure was unobtainable because both arms were affected. After the convulsion he became comatose but his lips were pink. The right pupil was dilated and inactive, the left one small. There was intermittent tonic spasm of the left leg and the left plantar response was extensor. There was no neck stiffness. Twenty-five and a half hours after injury he was still comatose; he was relaxed most of the time but had short attacks in which he went stiff and shook all over. Both pupils were large and inactive. The pulse rate had fallen to 110 but the temperature remained 102° F.

He took a second convulsion at the twenty-eighth hour. Two hours later he was quite comatose, with flaccid muscles and absent reflexes. Both pupils were dilated and inactive, and the respirations had become slow and irregular (16-20 per minute). His face was pallid, and there was slight cyanosis but the skin was hot and sweating. He appeared very ill and likely to die. The depth and frequency of respiration improved with carbon dioxide and oxygen inhalations and the cyanosis was relieved. He

remained comatose and flaccid with absent reflexes, but respirations rose to 45 and the pulse to 160, and his face became flushed and pink. The drip was discontinued at thirty hours because of suspected cerebral oedema. An hour later he showed rhythmic twitchings of the right hand, the arm being held stiffly extended. Still an hour later he was improved; the respirations were quiet (rate 50 per minute), the temperature 103° F., and the pulse 160. There was no peripheral vasoconstriction. The limbs remained flaccid. The left pupil was small, the right dilated.

At thirty-three hours the unconsciousness was less deep and he was restless with noisy and rapid respirations, and making slow athetoid movements of the limbs. The left plantar response was extensor. He made no response to stimuli. He was first noticed to respond at thirty-nine hours, when he cried out when pricked and resented being handled. The haemoglobin was normal, and the blood urea 68 mg. per cent. (He had passed only 120 c.cm. of urine in seventeen hours.)

Forty-six and a half hours after injury he opened his eyes in response to stimuli but would not speak. The pupils were inactive, the left knee jerk active and the right absent, and both plantars extensor. He remained in this semi-conscious state, not recognizing his parents but able to drink, for a further twelve hours. His skin was warm and dry; the cyanosis had gone; the temperature was 102° F. and the pulse 160.

After two and a half days he was conscious and resenting pricks. Both knee jerks were equal and active and both plantars flexor. The pupils reacted to light but the left remained larger. Haemoglobin was 10 g., temperature 102° F., and pulse 160. He was drinking well but passing very little urine. Two hours later he was again drowsy and taking no notice and the left plantar was extensor.

Next day he was conscious and talking, but very irritable. Both plantars were flexor, the left knee jerk ++ and right +. His temperature remained 102° to 103° F. On the fourth day he became very quiet again and was not drinking well. His face was flushed and he was found staring with noisy breathing, saliva dribbling from his mouth and rhythmic twitchings of his left face, hand, and arm. The legs were still, but the left knee jerk was increased and the left plantar extensor. The twitchings ceased after five minutes, and three hours later he was drinking again. Four and a half days from his injury he was drowsy and lay very still, but he was conscious and answered simple questions, and there was no spasticity of the limbs. He remained very apathetic and had a slow reaction time for another ten days or so, but ultimately made a very good recovery in four and a half weeks.

Phase of Secondary Infection and Wasting

Wasting and secondary infection were of marked importance only in lesions covering over 20 per cent. of the body surface, but in these cases they remained an ever-present problem. In this series bacterial infection usually became troublesome about the end of the second or third week and the B. pyocyaneus was a frequent offender. However, even under these conditions healing and skin grafting were not retarded, and it was difficult to know how much of the wasting should be attributed to bacterial infection, and how much to loss of 'purulent' material from a large granulating area.

The wasting, which tended to affect muscles even more than subcutaneous fat, was rapidly progressive in the severe cases, tending to become stabilized after four or five weeks but making no appreciable improvement until healing was well advanced. A proportion of the wasting can be attributed to the aversion from solid food shown during the first two or three weeks; during this period most of the children drank excessively, but unless they would take milk their calorie intake was very low. Later they usually ate very well and attained a high calorie intake for their age. If for any reason their morale failed, the appetite became very poor, and this was at any time an ill omen. It was noticed that appetite was often strikingly improved overnight by correction of anaemia with blood transfusion.

Anaemia of progressive character was seen in all severe cases, even where obvious secondary infection was not present. It was routinely corrected with blood transfusion. The most noticeable effect of anaemia appeared to be a lowering of morale, and of transfusion a raising of morale. The whole question of morale, which is probably the crux of the matter so far as management of this stage is concerned, can conveniently be considered here. As mentioned above, during the first two or three days it was very good. The children were co-operative, talkative, and cheerful. They did not voluntarily move about the bed but they did not mind being lifted, and they seemed to have little pain. It was, therefore, disheartening to find on the third or fourth day that they appeared to feel ill and to have much more pain and discomfort. From then on they became introverted and their illness was their primary concern and interest. They hated to be touched or moved, and cried whenever the bedclothes were taken down. Almost without exception in the bad cases, bedwetting commenced and became intractable—because they wished to avoid being lifted on and off the bedpan. Many of them became extremely quiet and would not answer when spoken to, often pretending to be asleep so that they would not be disturbed. Even among the older children, who would talk and smile quite naturally when undisturbed, fear of being moved was very obvious. Several small children used to howl continuously so long as they were uncovered but would stop immediately and become quite talkative when the bedclothes were put back. The tougher type of child took refuge in bad temper and negativism. One three-year-old boy used to answer every question and remark for many weeks with a surly 'no.' He threw toys and books

offered to him on to the floor, and hit out viciously at anyone who came near him. He made an exception, however, over food and always received meekly and quietly the nurse who came to feed him. When he had had enough, he pushed her away roughly and shouted ' no.' When he recovered he was a lively and good natured child.

In the early weeks the children usually slept a good deal, but lightly, and were readily awakened by noise or movement. They dreamed and started in their sleep, often waking up screaming. One little girl woke up regularly crying out, ' Nurse, Nurse, put out the fire, quick.'

Enough has been said to indicate the profound emotional upset which accompanies the physical illness, and the constant care which is required to ensure recovery. In more than one instance commencing dressings without anaesthesia caused an acute failure of morale with loss of appetite and rapid increase in wasting.

(The treatment of this phase will be dealt with later, see page 143.)

Miscellaneous Data

Blood urea levels. These were followed constantly for the first few weeks, and in some cases for several months. The highest level in any case was 80 mg. per 100 c.cm., and increases were usually associated with inadequate fluid intake during the first forty-eight hours, or later with wasting. No case of death in uraemia occurred. Table 4 shows the highest levels reached in all cases.

Blood sulphonamide levels. These were followed in about half the cases. At first sulphanilamide and later sulphathiazole powder was used as a local application on the dressings. Generally speaking they were absorbed rapidly and freely during the first two days, and thereafter to a much smaller extent, i.e. absorption was high during the period of fluid loss. Before this was fully appreciated some high levels were obtained; notably in case 3 it reached 20 mg. per 100 ml. of blood within two hours of dressing and was still 18 mg. per 100 ml. fourteen hours later. This child vomited excessively and later had a small haematemesis. In case 5 the level was 26 mg. per 100 ml. fifteen hours after the first dressing. However, as soon as reasonable care was taken in the use of the powder no further trouble was experienced; only two readings above 8 mg. were obtained, and the average was below 4 or 5 mg. per 100 ml.

The Leucocyte count. This was followed in fourteen cases. Table 5 shows the highest count on the first, second, and third days. The peak was reached usually within the first twelve hours. Thereafter there was a steady decline to about 8,000 to 10,000 after four or five days. Subsequent rises were found to correspond with secondary infection, but it seemed evident that the initial rise was a response to injury. In case 3 differential counts were done and showed a neutrophil response of 75 to 85 per cent., with a shift to the left most marked on the second day.

TABLE 4

BLOOD UREA LEVELS IN TWENTY-SEVEN CASES, SHOWING THE HIGHEST LEVEL DURING THE FIRST FORTY-EIGHT HOURS, AND SUBSEQUENTLY

Case No.	Number of samples	Period of days	Highest blood urea	
			in first 48 hours	after first 48 hours
1	4	7	61	45
2	3	5		32
3	7	10	34	36
4	4	7	23	21
5	7	28	52	32
6	15	6	29	54
7	10	10	68	50
8	10	10	32	29
9	5	8	36	50
10	6	12	48	37
11	9	14	32	29
12	12	26	35	36
13	3	6	52	32
14	13	38	80	45
16	14	6	60	76
18	9	7	29	30
19	7	19	50	40
21	10	19	39	38
22	14	50	56	48
23	12	56	70	48
24	8	10	47	42
25	4	4	48	35
27	19	56	40	50
28	15	56	64	60
29	9	35	58	38
30	12	42	56	38
31	12	27	43	39

TABLE 5
LEUCOCYTE COUNTS DURING FIRST THREE DAYS IN FOURTEEN CASES

Case No.	First 24 hours	Second 24 hours	Third 24 hours	Extent of lesion %
3	60,000	27,000	19,000	15
4	27,000	17,000		5
5	25,000	10,000	11,000	12
6	52,000	10,000	7,000	60
8	44,000	23,000	22,000	10
9	14,000	15,000	19,000	20
12	11,000	24,000	10,000	20
13	38,000	25,000		20
14	26,000	16,000	14,000	30
23	36,000	22,000	17,000	30
25	37,000	13,000		20
27	38,000	28,000	24,000	40
28	21,000	17,000	13,000	35
29	36,000	18,000	25,000	15

Haematemesis. This was seen in cases 1 and 3. In case 1 it was associated with cyanosis and convulsions and untreated plasma loss, and in case 3 with vomiting possibly due to a high blood sulphonamide level. It was of mild degree, and the material was either black when vomited or turned so on standing.

Severe melaena with epigastric pain and sudden fall in haemoglobin from 83 to 55 per cent. was seen in case 27 on the fifth day. The epigastric pain continued for several days, but the melaena did not recur; the pain was relieved by alkalis and milk. This child died of wasting and bronchopneumonia after ten weeks, but the autopsy showed no evidence of gastric or duodenal ulceration.

Fluid intake and output. This was found difficult to measure because of unknown loss in the dressings and frequent bedwetting, and occasionally because of vomiting. Thirst was marked during the presence of haemoconcentration, but vomiting was often marked in this period, and in several cases the vomit was equal to the intake by mouth for the first forty-eight hours. In the later stages thirst was usually associated with high temperature, sweating, etc., and was otherwise not excessive. Where the urine output could be measured it was roughly half the total intake by mouth after the first three days. Before that it was governed by the efficiency of intravenous therapy in restoring fluid lost from the burned area.

Examination of the urine. In most cases this showed nothing apart from a mild and transient albuminuria for a day or two. One child had a focal nephritis associated with wound sepsis which cleared up rapidly with penicillin, and another had haematuria after three months in bed and was found to have renal calculi, presumably due to stasis. However, in case 16 (deep burns 60 per cent.) the first urine passed, at twelve hours, was a dark red-brown colour, with a granular brown sediment (reaction acid, specific gravity 1020); albumin +++; Guaiac test strongly positive. Microscopically there were no red cells but many granular casts and much granular debris, presumably haemoglobin pigment being excreted by the kidney after intravascular haemolysis. The plasma of the early blood samples in this case was pink-tinged.

Convulsions. These were seen in five cases. It appears that they may be symptomatic of circulatory inefficiency and anoxaemia from untreated haemoconcentration (cases 1 and 5), or of hypertension from plasma reaction (case 13), or of the cerebral disturbance found in the 'toxic' phase (cases 7 and 20). The first type were seen frequently before the days of efficient resuscitation, but can certainly be avoided by proper treatment. In the second instance the hypertension was apparently precipitated by a too rapid administration of intravenous serum for the relief of marked plasma loss (fig. 14, L. K.). This will be mentioned again later (see page 148), but it was due to bad technique and could have been avoided.

The third type has already been discussed and must be regarded as symptomatic of the cerebral disturbance described above. Administration of oxygen or oxygen-carbon dioxide (95 to 5 per cent.) mixture was of value, and it may be advisable to transfuse enough plasma or serum to restore the haematocrit to the normal level, and so relieve any circulatory inefficiency, in spite of the apparent cerebral oedema.

Post-mortem Findings

Necropsy reports are available in all seven cases that died, and the findings are summarized below. The cases are grouped according to survival time.

Three cases died after five to six and a half hours; they had all very extensive deep burns and were not resuscitated in any way. These were: case 15, M. S., aged five years (60 per cent.); case 17, E. E., aged six years (75 per cent.); case 26, N. B., aged two years (60 per cent.).

The dura mater in cases 15 and 17 was tightly stretched, the surface vessels of the brain were intensely congested, and the convolutions were flattened, but there was no increase in the cerebellar cones. The venous sinuses were engorged with dark fluid blood. In case 26 there were no signs of increased intracranial pressure. Microscopically

all three showed venocapillary congestion (extreme in case 15) but no other change. Apart from slight cloudy swelling in case 26, and glycogen vacuolation in the other two, there were no liver changes. The lungs in case 17 showed slight, and in case 26 marked congestion, with slight oedema. In case 15 there was no undue congestion but moderate emphysema. In the kidneys in cases 15 and 26 there was pink-staining albuminous material in Bowman's capsule and in the tubules, and case 15 also showed some fragmentation of the cytoplasm and nuclear pyknosis in the convoluted tubules. Case 26 showed cloudy swelling in the convoluted tubules. The bladder was empty in cases 15 and 26 and contained only a small amount of cloudy urine in case 17. All three showed slight haemoglobin staining of the intima of the aorta, presumably the result of intravascular haemolysis. The adrenals showed no abnormality in cases 15 and 17; they were not examined microscopically in case 26.

Case 20, J. P., aged ten years, who had 50 per cent. very deep burns (electric and fire), died twenty-three hours after injury. (He was given intravenous plasma and saline, but insufficient to relieve the blood concentration; he became drowsy and irrational, had a convulsion, and died of respiratory failure after a lumbar puncture.) The brain weighed 1,400 g. (normal for age, 1,290 g.). The convexities showed slight convolutional flattening, the meninges were congested, and there was a well-marked cerebellar pressure cone. The histological appearance was normal. The liver sinusoids were congested but cells showed no necrosis or other change. There was increased consistency of the lungs with marked congestion and intra-alveolar haemorrhages. The kidneys appeared macroscopically normal, but microscopically there was swelling of the glomeruli with narrowing of the glomerular space, the capillary loops being collapsed and empty, and the tubules showed cloudy swelling. There were a few c.cm. of clear urine in the bladder. The stomach was distended and filled with solid, partially digested food. (He drank 86 oz. of fluid in the twenty hours after admission and vomited only once; he apparently absorbed all this fluid, while practically no digestion or absorption of the solids occurred.) Gross venocapillary congestion was the only change in the adrenal glands.

Case 6, C. N., aged eight years, who had 60 per cent. deep burns, died after five days. She had widespread purulent bronchiolitis and bronchopneumonia, pyaemic abscesses in the thyroid gland and kidneys, and an acute splenic tumour. Her brain weighed 1,270 g. (normal for age, 1,273 g.). The dura mater was tightly stretched, the meninges oedematous, and the surface vessels injected. The convolutions appeared slightly flattened, and the cerebellum showed a slight pressure cone; the histological appearances were normal. The adrenal glands were congested but showed no other change.

The remaining two cases died after six and eight weeks in a grossly wasted state. These were case 16, M. H., aged eight years, and case 27, S. C., aged ten years, both of whom had 40 per cent. deep burns. Both showed widespread bronchopneumonia, with lung abscesses in case 16. The liver in both cases showed fatty change, and in case 16 there was cloudy swelling and fatty change in the heart muscle. Both cases showed a septic spleen, and case 27 showed dehydration nephrosis.

TREATMENT

Treatment may conveniently be considered in three parts: firstly the local treatment, secondly the control of secondary infection and wasting, and thirdly the treatment of fluid loss by intravenous therapy.

Local Treatment

Immediately on admission the child was wrapped in a sterile sheet and pinned into it, so as to avoid as far as possible contamination from the atmosphere and from handling. The primary dressing in all but the very early cases of the series was delayed until relief and control of the fluid loss had been attained. This was considered to be an essential point because, not only is the concentration of the blood increasing steadily during the time taken over dressing, but there appears to be an increased rate of loss during the dressing, probably attributable directly to the trauma of cleansing, etc. Moreover, as has already been mentioned, general anaesthesia (open ether) relaxes the protective vasoconstriction and may produce a dangerous lowering of the blood pressure. Thirdly the warning signs are masked or disregarded in the post-anaesthetic period, i.e. rapid pulse is attributed to the operation, thirst and restlessness are unrevealed, and coldness and blueness of the extremities may be attributed to the effects of exposure and evaporation during the dressing, and so the condition may deteriorate badly before the danger is recognized.

The primary cleansing was carried out usually by 0·5 per cent. or 1 per cent. Cetavlon solution, and loose cuticle was removed. The dressing in the majority of cases was of tulle gras or vaseline gauze (sterilized in a hot-air oven at 160° C. for one hour) with or without sulphanilamide or sulphathiazole powder. In a few cases a 5 per cent. sulphathiazole cream was used. Coagulation therapy was not employed at all in this series. It was thought important that a thorough cleansing of the skin for several inches around the affected area should be carried out, and that dressings should be applied with great care to avoid joins at places where much movement occurs, such as axillae, neck, and groins; these would appear to be very obvious precautions, but experience showed that they were often neglected. The bandage should be applied with equal care and with the aim of completely sealing off the lesion from the exterior. Adhesive tape applied liberally on top of the bandages was found very useful, and dressings could be left completely undisturbed for six or seven days without gaps

developing. There is little doubt that much secondary infection is due to badly applied dressings and could be avoided with more care.

Dressings were done usually at five-day intervals, and, except in the mild cases, always under a general anaesthetic for the first three weeks. Sterile gowns, gloves, sheets, and towels were used. Sloughs were removed radically as soon as they could be without causing serious haemorrhage. In the later stages if there was secondary infection, and if the child would tolerate them, soap foam baths were given every other day, and proved useful in cleaning up the area for grafting. Some children, however, would not tolerate them (especially if they had been scalded by falling into a bath) and loss of morale and confidence ensued if they were persisted in. A light general anaesthetic, administered by a skilled anaesthetist, even at three- or four-day intervals, is a great deal less harmful to a child than painful dressings producing terror and screaming. The usual anaesthetic was ethyl chloride induction followed by open ether with continuous oxygen, but intravenous pentothal was used with success in some of the older children. Rectal pentothal was given on one or two occasions and proved fairly satisfactory, but it should only be used by an experienced anaesthetist. Avertin was tried in a few cases but was not satisfactory, the child being noisy and struggling.

Skin grafting in fourth- and fifth-degree lesions was commenced as soon as a clean granulating surface could be produced, usually after six or seven weeks in an extensive area. Anaemia was fully corrected by blood transfusion before each grafting operation, and systemic penicillin was sometimes given for seven to ten days afterwards. In the later cases of the series 80 to 100 per cent. takes were obtained. The great difficulty lay in finding a sufficient donor area and in several of the children the calves were all that was available and they were used up to five times at three-weekly intervals.

Control of Secondary Infection and Wasting

As already indicated, this was a complex problem and varying success was met with, usually depending directly upon the extent of the lesion. If, as is still the case in most hospitals, burns and scalds have to be nursed in general wards, the avoidance of a certain amount of secondary infection in severe cases (i.e. 20 to 40 per cent. of the body surface) appears practically impossible. In the later part of this series all the children were able to be nursed in single cubicles or two-bedded side wards, and they certainly did better. It should be noted, however, that a ten-day course of penicillin was given to many cases (a) on admission and (b) after each skin graft, and the relative effects of this and of the isolation have to be considered. Sulphonamides and penicillin were widely used both locally and systemically, and were of great assistance.

Pyocyaneus infection was troublesome but it did not appear to have much adverse effect upon the grafting. Applications of 0·5 per cent. solution of phenoxetol were used with success against this organism, but after several days of this treatment in case 27 phenol-like substances appeared in the urine, so judgment must be reserved as to its suitability. Soap baths were also effective against the B. pyocyaneus.

In the treatment of severe wasting the problem of feeding remains a difficult and all-important one. Apart from deficient intake there appears to be a greatly increased calorie requirement, and high protein diets have been widely advocated. To work out a satisfactory diet, however, and to persuade the child to take it, were two quite separate problems. Sufficient amounts of meat, beans, cheese, etc., were rarely tolerated and if pushed led to nausea and vomiting. Milk and egg shakes appeared the best solution, but they were only acceptable in large amounts to a few children ; among working-class children in this district milk is generally disliked (probably because they are unaccustomed to it), and to persuade them to take it was often impossible.

The inter-dependence of appetite, morale, anaemia, and secondary infection is very complex and of great importance in the successful management of this recovery phase; a deterioration in any one direction has adverse effects in the other three, and a vicious circle is readily set up; similarly, improvement in one direction leads to improvement in the others. Thus the avoidance of painful dressings by the use of general anaesthesia improves morale, appetite, and resistance to infection; and the relief of anaemia by fresh blood transfusion not only produces a striking improvement in the psychological condition but improves the appetite, reduces the liability to secondary infection, and is essential for successful skin grafting. In short, all aspects of this phase must be kept constantly in mind and their inter-dependence remembered if a quick recovery is desired.

Intravenous Therapy in the Phase of Fluid Loss and Concentration of the Blood

It is probably correct to say that if death from circulatory failure consequent on reduced plasma volume and concentration of the blood does not occur within thirty-six hours of the accident, it is then unlikely. On the other hand, cessation of adequate therapy within the first thirty-six hours can be followed by a relapse which may be fatal. The early recognition of developing haemoconcentration is essential because reversal in the later stages is technically much more difficult, and because sudden collapse may occur in a child who has appeared fairly fit to the inexperienced eye, and death may supervene if one is taken unawares and unprepared. As has been shown above, there is nothing mysterious about the cause of death in this stage; close observation reveals that warning signs are present long before the so-called collapse occurs,

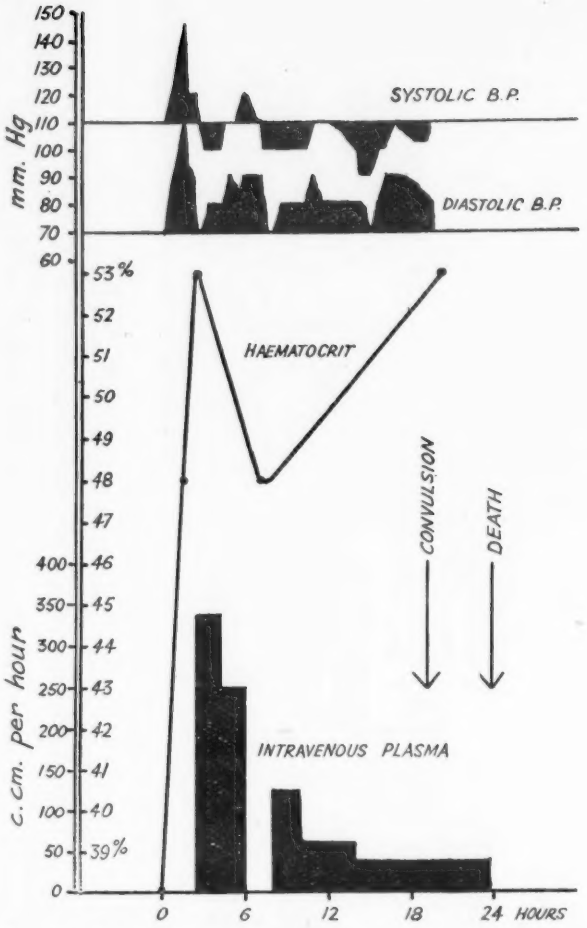

FIG. 9.—Case 20, J. P. Burns 50 per cent. Inadequate fluid replacement, convulsions, and death twenty-four hours after injury. Note the small pulse pressure: i.e. low systolic and high diastolic blood pressure. Hypertension is shown as a block above the normals (110 mm. systolic and 70 mm. diastolic) and hypotension as a block below the normals.

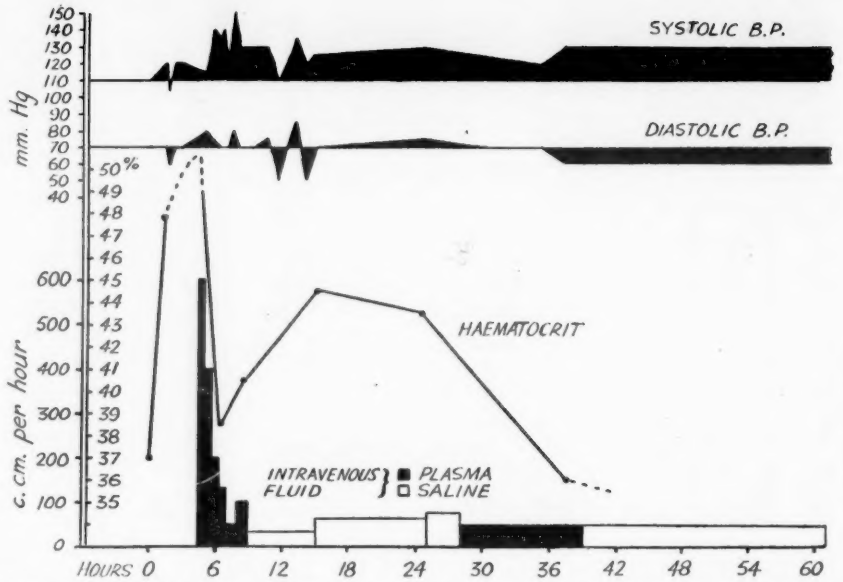

FIG. 10.—Case 11, E. S. Burns 20 per cent. Rapid rise in haematocrit and rapid fall in response to plasma transfusion. Secondary rise with inadequate replacement, and return to normal thirty-six hours after the injury. Note systolic hypertension.

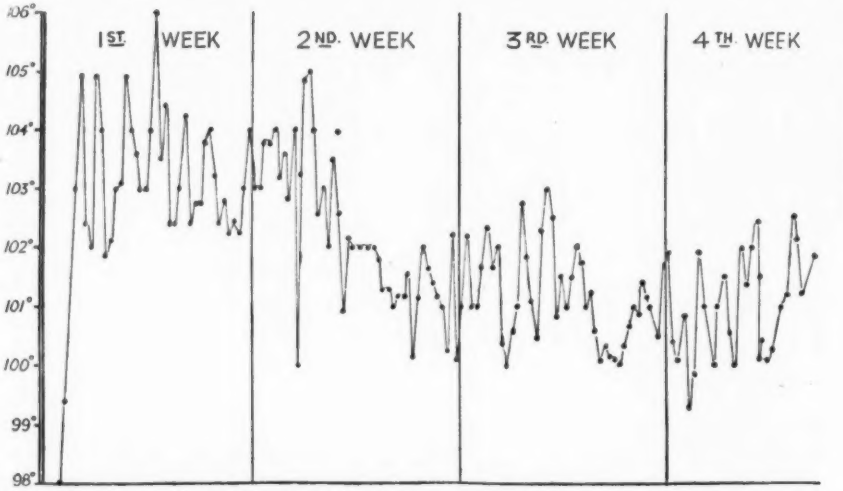

FIG. 11.—Case 30, C. R. Scalds 30 per cent. Four-hourly temperature chart (Fahrenheit) over first three weeks. Shows sustained character with gradual fall.

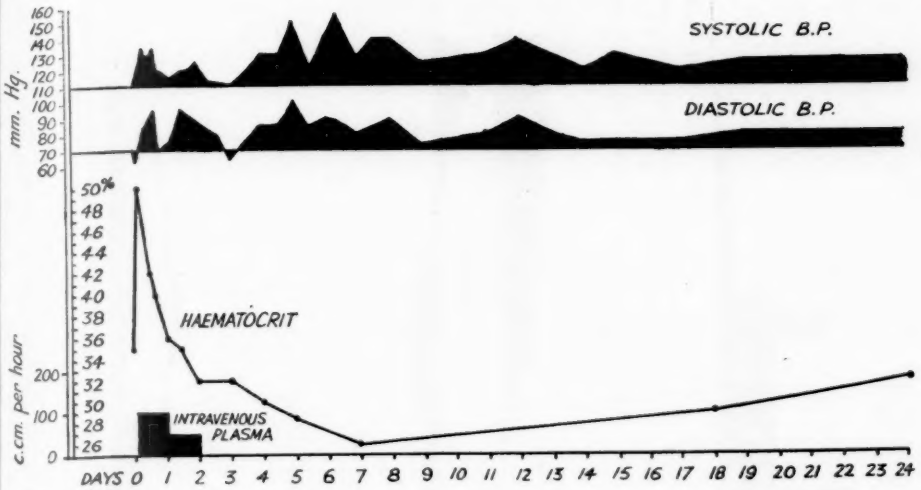
SYSTOLIC B.P.
DIASTOLIC B.P.
mm. Hg.
HAEMATOCRIT
INTRAVENOUS PLASMA
c.cm. per hour
DAYS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIG. 12.—Case 30, C. R. Scalds 30 per cent. Extensive sloughing. Hypertension over the first three weeks, during and after intravenous plasma therapy.

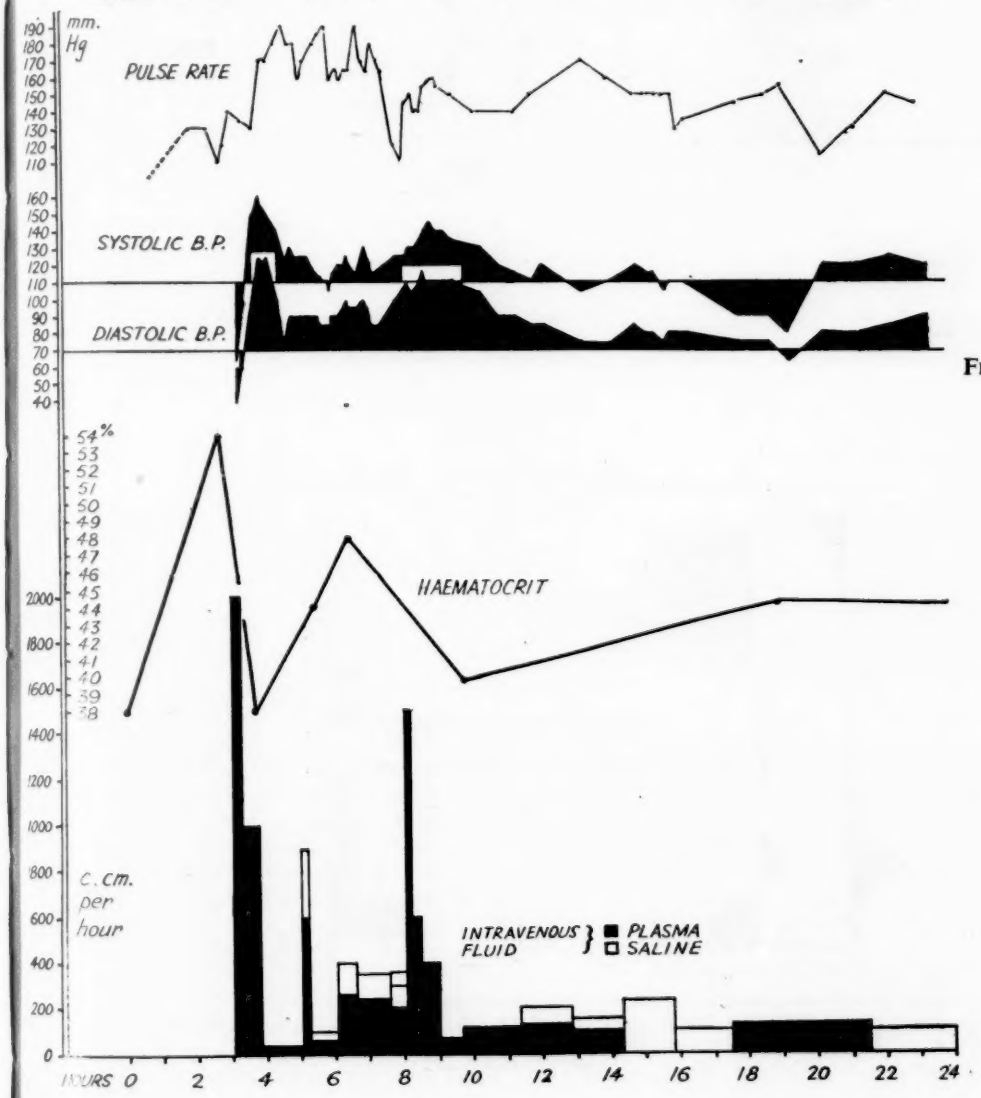

FIG. 13.—Case 16, M. H. Burns 40 per cent. The intravenous fluid in this case was given very irregularly (see text, page 147), and the resulting fluctuations in heart rate, blood pressure, and haematocrit during the first twenty-four hours are shown.

FIG. 11.—Case 30, C. R. Scalds 30 per cent. Four-hourly temperature chart (Fahrenheit) over first three weeks. Shows sustained character with gradual fall.

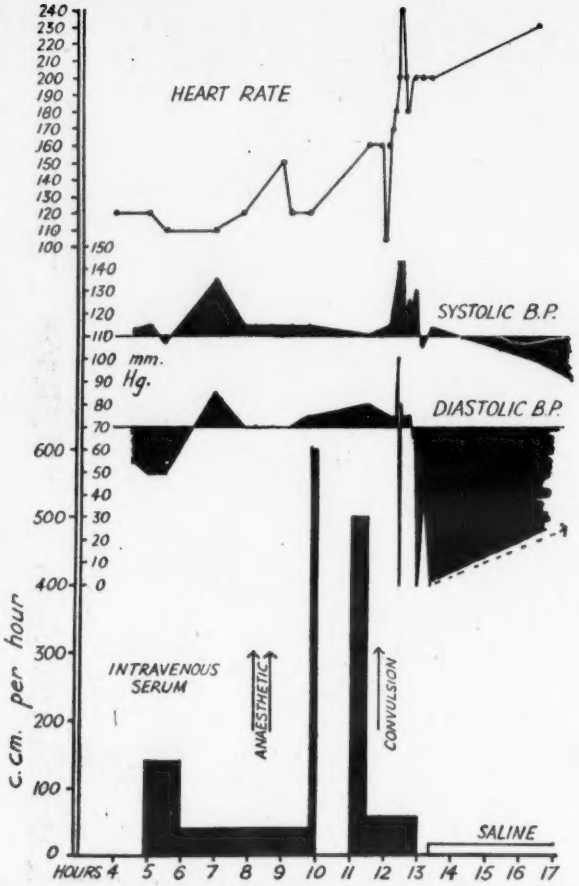

FIG. 14.—Case 13, L. K. Scalds 20 per cent. Aged two years. The amount of plasma given during the first nine to ten hours was inadequate and the child became cold, cyanosed, and restless. The transfusion eleven to eleven and a half hours after the accident was evidently too rapid and produced a plasma reaction ending in a convulsion; the rapid fluctuations in heart rate and blood pressure levels during the next hour are shown. (The case history is given on page 148.)

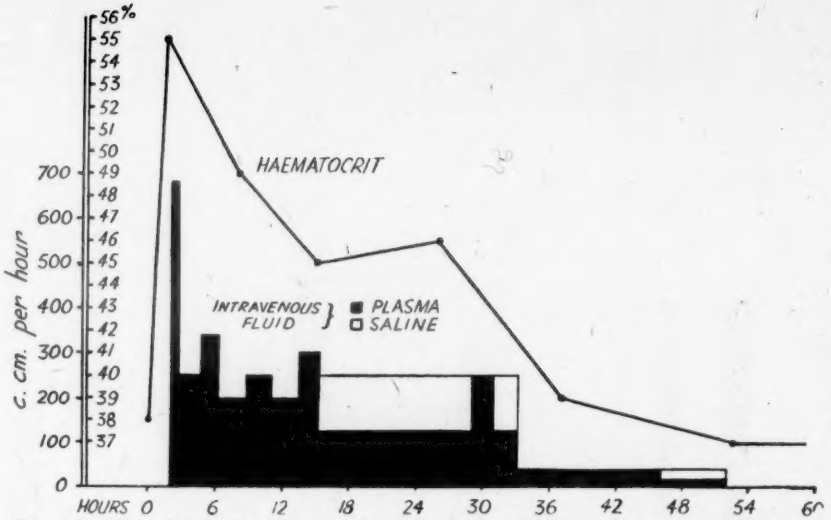

FIG. 15.—Case 27, S. C. Burns 40 per cent. Insufficient plasma was given and the haematocrit did not return to normal until after forty-eight hours. The secondary rise in the haematocrit after the plasma transfusion rate was halved twelve hours after injury is noteworthy.

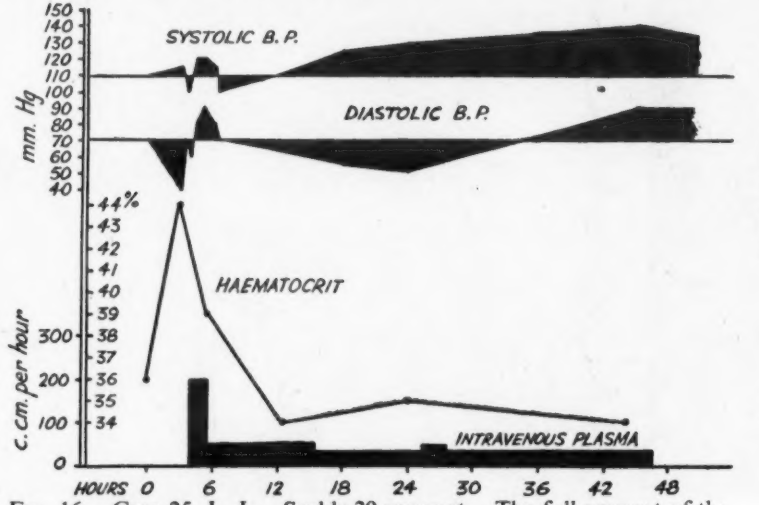

FIG. 16.—Case 25, L. L. Scalds 20 per cent. The full amount of the calculated plasma requirement was given, and the haematocrit reached normal at the twelfth hour and remained down. The hypertension is more marked during the second twenty-four hours.

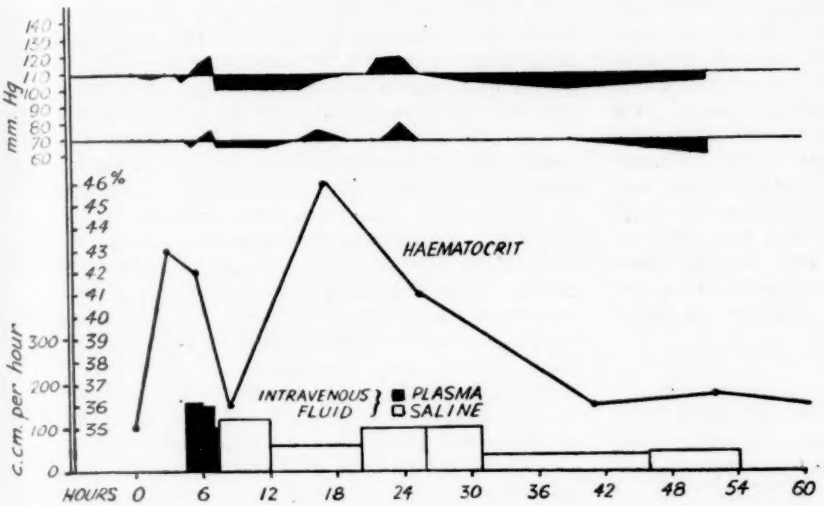

FIG. 17.—Case 8, E. D. Scalds 10 per cent. This case shows the fall in the haematocrit after plasma administration with a marked secondary rise when saline was substituted, and subsequent fall to normal after forty-two hours.

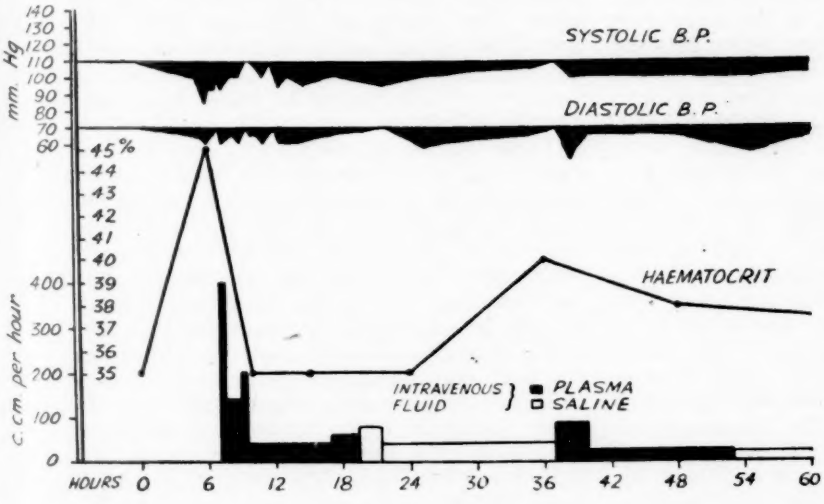

FIG. 18.—Case 12, M. B. Burns 20 per cent. The initial rise in haematocrit was corrected by plasma transfusion, but on substituting saline a secondary rise occurred and was not corrected by the end of forty-eight hours.

but failure to recognize their significance or to treat them promptly and adequately can have disastrous results.

In treating the first six or seven cases the need for intravenous fluid was judged largely by the clinical signs, and the results were checked against the blood findings. As already stated it soon became evident that the haematocrit value was a better index of the concentration of the blood than either the red cell count or the haemoglobin value, and it became the primary blood investigation. Over the period covering roughly cases 6 to 16, progressively more reliance was placed on the haematocrit, and the intravenous fluid was given with the aim of obtaining a definite value for this. The fluid was still given, however, rather empirically, and the rate adjusted frequently according to the results obtained. In this way there was a good deal of overshooting and undershooting the mark, and the patient made a chequered progress towards an ultimately satisfactory result. The best example of this was seen in case 16, M. H. (fig. 13).

Case 16. M.H. This child showed marked blood concentration at three hours, and would certainly have died without intravenous therapy. The fluid was given too rapidly, and although her haematocrit reached normal after only one hour, the signs of vasoconstriction persisted and the blood pressure rose steeply from 64/40 at three and a half hours to 160/120 mm. Hg at four hours. Owing to the danger of a hypertensive fit, the rate of administration was cut down drastically, but it was two hours before the blood pressure fell to normal and vasodilatation occurred. By this time the haematocrit had risen again to an undesirable level and the pulse rate was 190. After 200 c.cm. of two-thirds strength serum in thirty minutes the rate fell to 160. At seven hours

she was given a general anaesthetic (open ether and oxygen) and the burns were cleansed and dressed. After this she was cold, and the rate of the drip was increased so that she had a further 600 c.cm. serum between the eighth and ninth hours. She became warmer after 500 c.cm., but then the vasoconstriction returned and the blood pressure rose to 145/110. Eventually a compromise was struck, but the haematocrit remained on the high side for thirty-six hours. As it had been noticed that the hypertension subsided more rapidly when saline was given instead of serum, alternate 500 c.cm. of serum and saline were used. (The use of saline will be discussed later.)

Case 13. A similar state was seen in case 13, L. K. (fig. 14). This two-year-old child had second- and third-degree scalds over 20 per cent. of her body surface. The first haematocrit reading at six hours showed a deficiency of 30 per cent. of her total plasma volume; 150 c.cm. plasma had already been given intravenously, so the actual loss must have been considerably greater. After dressing under an anaesthetic (seven to eight hours) she showed clinical signs of increasing plasma loss, and the rate of flow was speeded up at the tenth hour. Unfortunately no haematocrit readings were obtained during this period and treatment was guided by clinical criteria. The drip began to leak and had to be taken down, and there was a delay of one and a half hours before it was finally restarted. By this time the child was cold, cyanosed, and very restless and unco-operative, screaming and struggling during the venesection. The tissues were bloodless and the vein practically empty, and venespasm was so marked that considerable positive pressure (syringe and three-way tap) was required to start the flow; 300 c.cm. of serum was given in the next forty-five minutes (the total plasma volume at this age is about 500 c.cm.). The restlessness diminished but she remained cold and blue with pulse rate 160 and deep and rapid respirations. She then suddenly had a convulsion with generalized clonic spasms and vomited. After the fit the pulse rate fell to 104 per minute, she became warm all over, and the breathing became quiet and easy. No blood-pressure reading was obtained during the attack, but fifteen minutes later it was 115/75 mm. Hg. In the next fifteen minutes the heart rate rose to 200 and the blood pressure to 145/100, the extremities became cool, and the respirations grunting and distressed; she was noisy and irrational, and another convulsion was feared. However, the vasoconstriction again relaxed within five minutes, the skin becoming hot and the blood pressure falling, but the heart rate remained 180 to 200. The drip had been continued at about 80 c.cm. per hour during this time; at the thirteenth hour it was turned off completely and the child passed into a quiet sleep. It was then discovered that the rectal temperature was 105·6°, which would explain the persistent tachycardia.

It seems likely that the above picture was the result of a reaction to plasma given too rapidly in an attempt to correct the concentration of the blood, which had been allowed to develop to a dangerous degree. In subsequent cases an attempt was made to estimate the rate of fluid loss from the circulating blood, and to calculate from this the total requirements for the first twenty-four hours. (The method of calculation has been explained on page 132.) In the last ten cases of the series intravenous therapy was based entirely on such calculations, and the results, both regarding the smoothness of progress and the state of the child at the end of twenty-four hours, showed a considerable improvement. The fluid already lost was given in addition to the calculated hourly requirement, over the first three or four hours of treatment. That is, if at the start of treatment there was a calculated deficiency of 400 c.cm. of plasma, and if the rate of loss was estimated at 80 c.cm. per hour, for the first four hours of treatment the rate would be 180 c.cm. per hour, and thereafter 80 c.cm. per hour. By spreading out the administration in this way, rather than giving the 400 c.cm. rapidly at the start, plasma reactions of the nature of those described above were avoided.

Table 6 shows the summarized data in twenty-four cases (data were inadequate in three cases and four cases were not resuscitated). It gives the results of calculations, the fluid actually given intravenously, and the haematocrit values after twenty-four and forty-eight hours. In making the calculations it was presumed (a) that the child had normal blood volume and haematocrit values for its age or size at the time of injury, (b) that the rate of fluid loss was fairly constant during the first twenty-four hours at least, (c) that no significant dilution from tissue fluids occurred if the haematocrit was kept at a reasonable level, and (d) that there was no significant loss of red cells from the circulation. It appears from the results obtained that these presumptions were permissible for the purpose of guiding treatment.

Discrepancies occurred between observed and expected results and were seen particularly in cases 11, 14, 16, 23, 24, 27, and 28.

In cases 23, 24, and 28, a normal haematocrit value at the end of twenty-four hours was obtained with considerably less transfusion than the calculated requirements. However, in none of them was the normal value reached under twenty-four hours, whereas in cases 25, 29, and 31, who were given the full calculated requirement, the normal was reached six to nine hours sooner (fig. 16, L. L.). The shape of the curves suggest that in the first group the rate of fluid loss had decreased towards the end of the first twenty-four hours, rather than that the original estimation of loss was too high. The occurrence of such diminished requirement becomes evident from serial haematocrit readings during therapy, and the rate of flow can be adjusted where necessary.

In cases 14, 16, and 27 the calculated fluid

TABLE 6

DATA OBTAINED FROM VENOUS BLOOD SAMPLES, WITH THE CALCULATED PLASMA LOSS AND REQUIREMENTS, THE QUANTITIES OF FLUID ACTUALLY GIVEN INTRAVENOUSLY, AND THE HAEMATOCRIT LEVELS BEFORE TREATMENT AND AT THE END OF TWENTY-FOUR AND FORTY-EIGHT HOURS*

Case No.	Haematocrit %		Haemoglobin g./100 c.cm.		Hours after injury	Normal blood volume (c.cm.)	Calculated plasma loss		Calculated plasma required per 24 hours (c.cm.)	Intravenous fluids given in first 24 hours		Intravenous fluids given in second 24 hours		Haematocrit % after	
	Normal	Abnormal	Normal	Abnormal			Total (c.cm.)	per hour (c.cm.)		Serum/plasma (c.cm.)	Saline (c.cm.)	Serum/plasma (c.cm.)	Saline (c.cm.)	24 hours	48 hours
1	36	40 (after 200 c.cm. I.V.)	12·0	13·5	36	1,000	100 +200	8	200			500			
3			12·5	17·5	7	1,400	400	60	1,400	1,500		500	50		
5	35	46	11·2	15·9	19	700	165	9	200	300		200	400	31	28
6	37	50	12·9	14·7	4	1,600	400	100	2,400	3,000	1,000	500	1,000	38	33
8	36	43			3	800	130	43	1,000	500	1,000		1,250	41	36
9	35	41			3½	500	70	21	500	350		75	150	36	34
10	35 35	41 44	11·5 11·5	13·1 13·6	3 6	750	110 150	37 26	880 620	500			1,000	36	39
11	37 37	48 39 (After 700 c.cm. I.V.)			1 6	1,200	275 60 +700	275 130	6,600 3,000	1,000	750	500	1,250	44	36
12	35	45	11·5	13·5	6	900	200	33	800	850	200	400	550	35	38
13	35	43 (After 150 c.cm. I.V.)	11·5	13·6	6	800	150 +150	50	1,200	700	100		600	36	
14	37	45 (After 300 c.cm. I.V.)	12·9	14·0	5	2,000	350 +300	130	3,100	2,750		750	300	41	38
	37	51 (After 400 c.cm. I.V.)	12·9	14·7	7		550 +400	136	3,250						
16	38	54	12·9	15·4	3	1,600	475	160	3,800	3,300	1,250	1,000	1,200	44	34
18	37	43	12·9	14·0	2	2,000	280	140	3,400	2,500	1,000	500	1,000	45	44
19	37	58	12·9	17·5	21	2,000	725	35	830	750		1,000	1,000	40	44
20	38 38	48 53			1½ 2¼	2,000	420 565	280 210	6,600 5,000	2,500	1,500			53	
21	37 37	39 42			1 2½	1,200	60 140	60 56	1,440 1,350	850	450	300	300	39	33
22	37	46	13·9	14·7	1½	1,500	300	200	4,800	3,000	2,500	750	2,250	40	35
23	36	49	12·5	14·6	2 +	1,000	265	106	2,500	2,000	1,000	700	700	37	29
24	36	45	12·5	13·2	4	900	180	45	1,100	600	400	300	300	36	35
25	36	44	12·5	15 +	4	900	160	40	960	900	100	650		35	33
27	38	55	13·0	16·8	2	1,500	460	230	5.500	4,500	1,000	2,500	1,500	46	37
28	37	52	12·6	14·4	1½	1,300	375	250	6,000	4,600		1,900	200	35	36
29	36	47	12·5	14·0	4	900	210	53	1,260	1,400		600		36	33
30	35	50	11·5	15·4	2½	750	225	90	2,200	2,300		1,300		36	32
31	37	43	12·6	15·0	1½	1,200	170	130	2,700	2,200		1,300		34	31

* Haemoglobin values are given alongside the haematocrit values, but they were not used in the calculations except in case 3.

requirement was insufficient to produce a normal haematocrit value at the end of the first twenty-four hours (fig. 15, S. C.). But it will be seen from the table that the actual quantities given, which were decided by clinical criteria, were even further from the mark.

Case 11 shows the really outstanding discrepancy (fig. 10). The original haematocrit value was obtained from the whole blood specific gravity (Van Slyke copper sulphate method) and was not a direct measurement; also the exact time of injury was uncertain. Even so, the calculated requirement seems extraordinarily high. Therapy was guided by clinical criteria and the quantity given was obviously inadequate, but not to anything like the extent suggested by the calculation.

In the remainder of the cases the actual and expected results for the amount of fluid given showed good correlation. Where less than the calculated requirement was given the haematocrit remained raised, and where the full amount was given it had returned to normal after twenty-four hours. In many cases the haematocrit was purposely kept higher than normal, as it was at one time felt that the danger of cerebral oedema might be lessened in this way. However, for reasons already given, it is not now considered harmful and may be safer to relieve the haemoconcentration completely. Fig. 9, J. P., illustrates this point.

In practically every case charts were made of blood pressure readings, haematocrit levels, and intravenous fluids, but space does not allow of their all being included. Those shown have been picked to illustrate the points made in the text, but they are typical examples and they give a fair representation of the results obtained from different criteria of treatment.

Lastly the nature of the intravenous fluid must be considered. In many cases either a mixture of saline and serum or plasma, or alternate 500 c.cm. bottles of them were used, for the following reasons. (1) There was a shortage of liquid serum and plasma and the dried plasma was not satisfactory for administration to children. (2) It was undecided whether saline was of value in correcting the concentration of the blood. (3) In some cases with oliguria 0·2 per cent. saline and 4 per cent. dextrose was given to increase the urinary output. (4) In some cases rather high plasma protein values were found and it was felt that the fluid lost from the burned areas may have a lower protein content than pure serum.

The first reason no longer exists. The second has been settled; it appears that saline solutions per se are of practically no value in relieving the abnormal concentration of the blood after burns and scalds. This was shown in cases 6, 8, 11, 12, 16, 18, 21, 22, and 27. It is well illustrated by figs. 10, 17, and 18, which show a rise in the haematocrit when saline was substituted for serum or plasma.

In the case of low urine output, where the circulation is satisfactory but where the patient cannot take fluids by mouth, there is an indication for giving saline intravenously, but it should be given in addition to and not instead of proteinous fluid.

The fourth reason only applied in certain cases; it may be advisable occasionally to dilute the plasma or serum with a certain amount of saline, but this can be stated to be generally unnecessary.

Between plasma and serum no obvious difference was noted, though the protein content of plasma must be less because of the citrate solution added when the blood is collected. The plasma was the more usually available and it proved quite satisfactory in use.

SUMMARY AND CONCLUSIONS

1. Thirty-one cases of burns and scalds in children were studied. An attempt was made to define the symptomatology of the different phases of the constitutional disturbance, and to correlate the physical signs with simple haematological data.

2. The main cause of illness and death in the early stages is reduction of blood volume by plasma loss. Early and adequate replacement by transfusion is essential for recovery in the type of case studied; therefore the recognition, assessment, and treatment of plasma loss is of prime importance during the first forty-eight hours.

The physical signs of reduced plasma volume are thirst, peripheral vasoconstriction, drowsiness, restlessness of spasmodic type, and eventually mental confusion and loss of consciousness. These signs constitute a specific indication for intravenous therapy and must never be disregarded. Hypotension is a late sign, and treatment should never be delayed pending its appearance.

3. The haematocrit value is a more sensitive index of fluid loss and a better guide to treatment than the clinical state, though they should always be considered in conjunction. Calculations from haematological data show that up to 30 per cent. of the plasma volume may be lost from the circulation before clinical deterioration is obvious, and death probably occurs when 60 to 70 per cent. of the plasma has been lost. Allowing for the rapidity with which the concentration of the blood can increase, it is therefore unsafe to be guided solely by the clinical state, unless the child is under constant and skilled observation, and even then the margin of safety is considerably greater if haematological data are utilized.

4. Certain ' toxaemic ' signs may be seen during the second twenty-four hour period and in the succeeding weeks. Their nature is not understood but they do not appear to be due to either fluid loss or secondary infection. They are: (a) sustained pyrexia and hyperventilation ; (b) moderate sustained hypertension ; (c) nervous signs suggesting

increased intracranial pressure and possibly due to cerebral oedema.

Hypertension occurs frequently in cases of burns and scalds, both during the administration of plasma and serum and in the succeeding weeks. There appears to be a definite individual liability to it.

Cerebral oedema probably occurs in severe cases (clinical and post-mortem evidence) and is not due to overadministration of intravenous fluids, because the picture is seen in inadequately resuscitated or unresuscitated cases.

5. The problems of the recovery period are secondary infection and wasting and they are interrelated. The maintenance of good morale during this period is of paramount importance, and the relief of anaemia by blood transfusion and the avoidance of painful dressings are decidedly helpful in this respect.

6. The blood urea shows only slight or no increase (the highest level recorded in the series was 80 mg. per 100 c.cm.), and the rise is usually associated with inadequate fluid intake or with wasting.

7. Sulphonamides are absorbed rapidly from the burned areas during the first two days and care must be taken in their application.

8. The leucocytes may show a rapid rise to the region of 30,000 or 40,000 within a few hours of the injury. The leucocytosis subsides gradually over three or four days and is probably a specific reaction to injury. Secondary rises in relation to infection are less marked and occur later.

9. Convulsions may be symptomatic of three conditions: (a) circulatory inefficiency from untreated plasma loss; (b) hypertension during plasma and serum reactions; (c) the cerebral disturbance of the ' toxic ' phase.

10. Saline solutions are of little or no use in the relief of marked plasma loss, but may need to be given in addition to serum or plasma where the urine output is low and the child unable to drink.

The occurrence of burns and scalds is a social problem. About 90 per cent. of the accidents occur in the home. Many could be avoided by the provision of proper fireguards or space for the children to play in away from the kitchen hearth. Recovery from a case of any severity is necessarily a long and painful process, lasting many weeks or months. The constitutional disturbance is severe and may endanger life in several ways. Any measure taken to improve treatment can never remotely approach in value any measure taken towards prevention.

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(For Figs. 1 to 8 of this article see Plates IV-VI.)

THE EXCRETION OF 17-KETOSTEROIDS AND GONADOTROPHIN IN CHILDREN: NORMAL AND ABNORMAL CASES*

BY

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Normal development in childhood, and the sex differentiation in growth which is a feature of this development, is essentially a matter of the activity of the anterior pituitary gland and the ability of the peripheral endocrine organs to respond to its stimulation. Developmental anomalies in childhood, as in adult life, may be due to abnormalities either of pituitary secretion or of the gonads, adrenals, or other endocrine glands. The techniques which are available for the study of sex anomalies in the adult are applicable to an investigation of the sex mechanism of childhood, but relatively little work has been done in this field and it tends to be of a conflicting nature. Nathanson et al. (1941) have carried out a fairly elaborate investigation of the secretion of oestrogen and 17-ketosteroids in a group of normal girls and boys, and have been able to detect small, though fairly constant, amounts of both hormones in children between three and seven years of age. At about seven years the excretion of 17-ketosteroids, which up to then had ranged from 1·5 to 4·5 mg. in twenty-four hours, rose in both sexes to between 3 and 7 mg. a day. Boys from nine to eleven years tended to increase in androgen output more rapidly than girls, whose oestrogens increased more rapidly than in boys. Hormone output was correlated with physical development rather than with chronological age. Cycles in oestrogen excretion became obvious in girls at about the age of ten or eleven, and the rate of excretion greatly increased after eleven up to the menarche. This finding confirmed that of Frank (1935). That there is considerable divergence in the figures reported for androgen excretion in children is shown in table 1. Owing to the difficulty of comparing the biological unit with the colorimetric, data expressed in the former have not been given.

TABLE 1

DATA REGARDING DAILY EXCRETION OF 17-KETOSTEROIDS BY CHILDREN

Author	Age of children : yrs.	Range of excretion: mg.
Patterson et al.	$1\frac{8}{12}$	less than 0·6*
Oesting and Webster ..	3	0·3
	14	1·5 to 2
Chou and Wu	under 10	0·2 to 1·1
Koch ..	$6\frac{1}{2}$-10 (boys)	0·07 to 0·2*
	8-10 (girls)	0·18 to 0·2*
Talbot et al. ..	under 7	0·8 to 2·6 (aver. 1·3)
	7-12	1·8 to 5·0 (aver. 4·0)
	12-15	5·0 to 11·3 (aver. 8·2)
Nathanson et al.	3-7	1·5 to 4·5
	7-9	3·0 to 7·0
	9-12 (boys)	4·0 to 12·5
	9-12 (girls)	3·0 to 12·0
	12-15 (boys)	6·0 to 18·0
	12-15 (girls)	6·0 to 17·0

* = per litre of urine.

Review of the Literature

The result of investigations in the last few years has been to show that the excretion of 17-ketosteroids is an imperfect index of the androgenic activity of the gonads, and that, although there is some degree of correlation of androgen excretion with sex and age, a considerable proportion of the androgen found in urine is secreted by the adrenal cortex (Callow and Callow, 1940; Callow et al., 1940), so that after castration the androgen content is only slightly below normal values. Evidence in support of this observation is afforded by the greatly enhanced excretion of 17-ketosteroids recorded in cases of hyperplasia and tumour of the adrenal cortex. It follows that a knowledge of the 17-ketosteroid excretion is of value in cases of excessive or deficient sexual development, especially if due to adrenal disease; and, when combined with a knowledge of pituitary activity, as reflected in the gonadotrophin excretion, it may provide an important aid to diagnosis.

* This investigation was carried out during the tenure of the Kirk Duncanson Fellowship from the Royal College of Physicians, Edinburgh, for which the author expresses indebtedness.

An efficient and inexpensive method of measuring gonadotrophin excretion has not been forthcoming until recently. Using the ethyl alcohol precipitation method of Aschheim and Zondek, Nathanson et al. (1941) were unable to detect below 20 mouse units of gonadotrophin in a twenty-four hour output of urine, and consequently failed to detect follicle-stimulating hormone in girls under eleven and in boys under twelve to thirteen years old. They expressed the opinion that more efficient methods might demonstrate its excretion at an earlier date. Using a tungstic acid precipitation method, and taking uterine weight as their mouse unit instead of ovarian stimulation (which Nathanson et al. employed), Catchpole et al. (1938), and Catchpole and Greulich (1940) were able to detect as little as two mouse units of gonadotrophin in twenty-four hours; yet they failed to detect any in the urine of boys under eleven, and only between two and ten mouse units in twenty-four hours in the urine of twelve out of fifteen boys between the ages of twelve and sixteen years. They considered ten mouse units to be 'essentially an adult figure.' Prepubertal and adolescent girls had a daily excretion which ranged from three to ten mouse units, and excretion became more frequent and increased to 20 mouse units as the menarche was approached. Gonadotrophic activity was demonstrable for at least a year prior to the menarche. In this they confirmed the observations of Katzman and Doisy (1934) and of Frank (1935). The latter stated that just before the menarche the amount of follicle-stimulating hormone excreted was half the adult amount. Frank was able to detect its secretion at four years of age, and found that at nine the value had doubled. As in the case of oestrogen and ketosteroids, the amounts of gonadotrophin recovered were related to developmental status rather than to actual age.

It follows that in developmental irregularities, e.g. dwarfism, Fröhlich's syndrome, sexual and somatic precocity, and sexual retardation (as in cases of undescended testes), it is helpful for the clinician to know whether there is excessive or reduced function of the pituitary. As sexual precocity may be due to a tumour in the gonads or adrenals or to a lesion in the brain, or may be merely of the constitutional type (of which examples have been given by Novak, 1944, and by Hain, 1947b) a knowledge of hormone excretion may supply valuable aid in differentiating between these conditions.

Excretion in Normal Children

In order that the data obtained in pathological cases might be compared with a standard of normals based on the same methods, and also with other standards, the excretion of 17-ketosteroids and of gonadotrophin was ascertained in a number of normal children of both sexes (tables 2 and 3). The methods of hormone extraction were those described by Hain (1947a): that is, for 17-ketosteroids, the method of Patterson et al. (1942), in which hydrolysis of 20 c.cm. urine with 3 per cent. sulphuric acid was followed by ether extraction and subsequent separation of the oestrogens from the androgens. The final product in alcohol was used for colorimetric estimation with *m*-dinitrobenzene,

TABLE 2

EXCRETION OF 17-KETOSTEROIDS AND GONADOTROPHIN BY NORMAL GIRLS.

Case No.	Age in yrs.	17-ketostds., mg./24 hrs.	Gonadotrophin, M.U./24 hrs.
K32	5	2·5 1·4	not done
K206	6½	2·2	4-5
K217	7	1·3	<2
K209	7	1·8	10
K205*	8	7·1	4-5
K216	8	2·6	not done
K211	8½	1·3 1·7	<2 <2
K210	8½	2·0	<2
K207	9	2·7	3
K208	9	2·2	4-5
Range	5-7 8-9	1·3 to 2·5 1·3 to 7·1	<2 to 10

* appendicitis.

TABLE 3

EXCRETION OF 17-KETOSTEROIDS AND GONADOTROPHIN BY NORMAL BOYS

Case No.	Age in yrs.	17-ketostds., mg./24 hrs.	Gonadotrophin M.U./24 hrs.
K31	2	0·6 (1·8*)	not done
K218	8	not done	<2 (only 110 c.cm. urine passed)
K203	8	4·1 (5·5*) (4·1*)	18
K219	8½	2·4	<2
K214	9	3·6	2·3
K204	9½	3·0	18
K201	10½	(3·6*)	14
K202	11½	3·8	17
		4·8	6
		3·3	4
		2·0	2
		2·6	10
		5·3	3
K213	14	6·0	14
		5·9	28
Range	8-11½ 14	2·4 to 5·3 6	< 2 to 18 14 to 28

* = per litre of urine.

readings of the colour intensity being made in a Spekker absorptiometer. The ketosteroids value was assessed from a calibration curve constructed from standard solutions of androsterone. For gonadotrophin estimation, the twenty-four-hours output of urine was brought to pH4 with glacial acetic acid, and the hormone adsorbed on 20 per cent. kaolin. After centrifuging, the kaolin was extracted with strong alkali and the supernatant made weakly acid before injection into immature mice. The mouse unit was based on uterine weight plus vaginal response.

The values for 17-ketosteroids are in agreement with those of Talbot et al. (1940) for the age groups covered. A discordant note is struck by the girl K205, whose rather high output of androgen may have been the result of general hyperaemia in the abdomen (due to appendicitis) causing temporarily increased adrenal cortical activity. It can be seen that boys tend to excrete more androgen than girls of the same age.

Gonadotrophin excretion could be detected before the seventh year in girls, and before the ninth year in boys; the tendency was for the output to be higher in boys than in girls up to the tenth year. A boy of fourteen excreted as much as many adults (Werner, 1943).

Excretion in Abnormal Children

The data given in tables 4 and 5 (p. 157, 158) relate almost entirely to children with developmental abnormalities. Generally the excretion of both 17-ketosteroids and gonadotrophin was ascertained, but in a few instances an A.Z. test was done instead of a gonadotrophin estimation, for reasons to be explained. In cases of adrenal cortical tumour or hyperplasia, the pregnanediol output was generally estimated in preference to that of gonadotrophin, as the adrenal cortex secretes progesterone; in one case (K181) the excretion of both pregnanediol and gonadotrophin was ascertained.

Girls: table 4. Menstruation occurred in six girls between the ages of two and ten years, and in a seventh girl aged eleven, in whom breast development was very marked. But for this last feature, this case might have been considered within normal limits. Precocious menstruation may be due to any one of six causes: granulosa-cell tumour; lesions of the hypothalamus and third ventricle; adrenal cortical tumour, ovarian cysts, and tumours other than granulosa-cell; the Hand-Schüller-Christian syndrome, in which bone cysts are present; and, finally, ' natural ' or ' constitutional ' precocity for which no known pathological cause has been found. The occurrence of ' constitutional ' precocity in girls and boys has recently been described by the author (Hain, 1947b), who also cited instances of all the above varieties reported in the literature. In all cases of precocious menstruation it is necessary to test the urine (a) for an excess of oestrogen, which in granulosa-cell tumours is excreted so abundantly that less than 3·0 c.cm. of urine causes the maximum oestrogenic reaction in an ovariectomized mouse, and (b) for an excess of luteinizing gonadotrophin. In cases of ovarian carcinoma and teratoma and embryonic tumours, a positive A.Z. result is obtained with less than 3·0 c.cm. of urine; and in cerebral tumours, other than those of embryonic type, 5·0 c.cm. of urine causes marked uterine enlargement without a macroscopic effect on the ovaries of the mouse injected. If an A.Z. test is entirely ineffective, an excess of oestrogen is excluded at the same time as an excess of chorionic gonadotrophin, thus restricting the number of possible causes of the precocity. The excretion of normal or only slightly raised amounts of 17-ketosteroids rules out adrenal cortical involvement, with which very high values are usually associated. We are then left with ' constitutional ' precocity as the most likely cause of the condition. The cause of constitutional precocity is not known; but, from the few facts collected so far, it seems that pituitary secretion, as measured by gonadotrophin output, starts at an earlier date or in larger amounts than in the average child of the same age. That this is not the whole story is suggested by the following: (1) no gonadotrophin was recovered in the two youngest children with vaginal bleeding: K339 and K319, aged two and a quarter and two and a half years respectively; (2) one of the ' precocious ' girls (K158, aged six and a half years) excreted eight mouse units gonadotrophin in twenty-four hours, whereas K209, aged seven, who excreted ten mouse units a day, was ' normal '; (3) two girls (K294 and K317), though secreting as much gonadotrophin as adults, did not menstruate although their development in other respects was in advance of their age. It seems likely, therefore, that in cases of precocity of the ' constitutional ' type there is not only premature pituitary secretion (or secretion at levels above normal) but also premature gonadal response. The latter was manifest in the formation of ovarian cysts as well as menstruation in at least four of the cases in table 4, and in almost adult development of the gonads and sex characters in two of the boys, P519 and K263, in table 5. This difference in tissue response possibly accounts for one patient showing rapid skeletal development whereas another developed menstrual function under the same stimulus.

Enlargement of the breasts may be the result of abnormal response to normal stimuli in some cases, or may have a pathological etiology. Tests performed with the natural urine showed no excess of oestrogen or of gonadotrophin excretion in the two girls with this anomaly (P516, K303), and the only feature was a 17-ketosteroid output above normal limits. The possibility of an adrenal basis for the condition might therefore be considered. The following facts support such a possibility. (a) Van Heuverswyn et al. (1939) state that desoxycorticosterone acetate caused mammary development in both normal and castrated male mice, a finding which was confirmed by Chamorro

(1940), who considers that the action may be by way of the pituitary as doca had no effect on the mammae of hypophysectomized mice. (b) In two women with mastitis and two men with gynaecomastia a 'pregnane derivative' was recovered which was in every way similar to that excreted by a woman with adrenal carcinoma, who, prior to its recovery, had excreted large amounts of pregnanediol (Hain, 1947a). (c) The association of adrenal tumours with gynaecomastia in men has been recorded in at least five cases.

Two of the three girls described as undersized may have been deficient in pituitary function, as no gonadotrophin was recoverable; in the third case —K344—excretion was normal.

With one exception (P323), all the girls with virilism excreted excessive amounts of 17-ketosteroids; P323 excreted four or five times as much as the average three-year-old, but surprisingly little for one with an adrenal tumour (which was found at operation), and as compared with K30, a child of almost the same age whose output was over 300 mg. in twenty-four hours. K30 excreted no pregnanediol, whereas P323 did. On the basis of 17-ketosteroid output it was not possible to discriminate either between hyperplasia and a tumour of the adrenal cortex, or between these and a virilizing tumour of the ovary (K181). In this latter case not only were large amounts of pregnanediol excreted, but also of gonadotrophin (fifty-five mouse units in twenty-four hours), which suggests that the absence of normal ovarian function had so reacted on the pituitary as to cause heightened secretion of gonadotrophin. A similar case will be described later, a cryptorchid male: K161. It would be interesting if virilizing ovarian tumours could be distinguished from adrenal cortical tumours by means of an excessive gonadotrophin output in cases of the former.

Boys: table 5. Precocious development occurred in five boys under eleven years old, of whom the youngest was only twelve months old. Such precocity can be due to one of four causes: cerebral tumour; testicular interstitial cell tumour; hyperplasia or tumour of the adrenal cortex; or 'constitutional' precocity. Three cases of the last named occur in table 5: K345, who, though only twelve months old, excreted almost seven mouse units of gonadotrophin in twenty-four hours; and P519 and K263, who, at five and six and a half years of age respectively, excreted as much gonadotrophin as adult men, and almost as much 17-ketosteroid. In each case the A.Z. test had been negative, making it unlikely that a cerebral tumour or tumour of embryonic type was responsible for the condition. These cases are described by Hain (1947b).

The case of P510, in whom sexual precocity was due to an interstitial cell tumour of the testis, is of special interest as only nine others have been reported in the world literature since 1895; it has been the subject of a special report by Horne et al. (1947). The 17-ketosteroids excreted by this infant, though equal to the output of an adult man, were not so high as frequently occurs in cases of adrenal tumour. Owing to the rarity of testicular tumours in children, adrenal hyperplasia or tumour was suspected, and it was only post mortem that the testicular abnormality was found. It would appear that in neither sex can differentiation be made between adrenal and gonadal virilizing tumours on the basis of 17-ketosteroid output. In the case of the boy the urine received was not sufficient to permit of an estimation of the gonadotrophin excreted, as was done for K181, who had an ovarian tumour. That the output was not such as occurs in presence of a seminoma or teratoma was shown by the negative reaction to the A.Z. test.

The only boy with an adrenal cortical tumour (K148) excreted 84 mg. 17-ketosteroids, and was in every way (except mentally) as developed as a man of eighteen. His case is described in a report on adrenal tumours (Hain, 1947a).

P512, whose abdominal tumour proved to be a neuroblastoma, had a normal 17-ketosteroids output.

Sexual under-development comprised a large group, in which complicating features were present in some cases. In two of the three 'dwarfs' the excretion of 17-ketosteroids was satisfactory; in the third, whose dwarfism was of the Lorain type, total pituitary function was undoubtedly impaired, and as a result adrenal cortical activity also was reduced. With the possible exception of K170 the boys of Fröhlich type had a satisfactory excretion of 17-ketosteroids but a low gonadotrophin output, suggesting deficient pituitary secretion in one direction. In K68, whose sexual under-development was associated with diabetes of long standing, the excretion of corticotrophic hormone was probably reduced, as well as that of gonadotrophin, as the result of impairment of total pituitary function, since both the ketosteroids and the gonadotrophin were low.

The boy with gynaecomastia (K342, aged eleven), excreted normal amounts of ketosteroids but gonadotrophin was excessive, so that blood-spots (which denote a high concentration of luteinizing hormone) formed in the ovaries of the mice injected with the urinary extract. Klinefelter et al. (1942) describe a syndrome characterized by gynaecomastia and hypogonadism (small testes and aspermatogenesis but normal phallus, prostate, and pubic hair) plus increased excretion of follicle-stimulating hormone (F.S.H.) and usually low 17-ketosteroids. Oestrogen excretion was not above normal. They considered it likely that the condition was due to the excessive secretion of F.S.H. and the absence of luteinizing hormone; testosterone failed to cause an improvement, and they suggested that luteinizing hormone might be tried. Their findings confirmed those of Bronstein (1939) and Turner (1939). In the boy K342 there does not seem to have been any deficiency of luteinizing hormone but rather an excess, as it is rarely that

one can detect its excretion in cases other than those in which chorionic tissue is present. Its excretion by menopausal women and by people of both sexes with hypertension and obesity is not uncommon (Hain, 1947c).

The remaining two patients, K122 and K161, are male pseudo-hermaphrodites (that is, they had testicles but female external secondary characters); in the older patient, who is being brought up as a girl, the tiny testicles found lying in the internal ring were removed. Her case has been fully described by Hain and Schofield (1947), and stress has been laid on the very high excretion of gonadotrophin (F.S.H.) before operation, which was undoubtedly due to the patient being, to all intents and purposes, a castrate. A boy castrated at the age of twelve was found to be excreting from 100 to 300 mouse units F.S.H. per litre of urine during the two years that Hamburger (1933) observed the case; it would appear that the condition is an exaggeration of that observed at the menopause, and in people of both sexes in whom the gonads make little or no response to pituitary secretion (Hain, 1947c). The excretion of excessive amounts of gonadotrophin in a case of doubtful sex, especially in the absence of a high ketosteroids output and of any pregnanediol, may be regarded as strong presumptive evidence in favour of the patient's being a male pseudo-hermaphrodite, since a similar morphological picture in the female is associated with a hyper-secretion of 17-ketosteroids, and sometimes of progesterone also, either by the adrenal cortex or by a similar structure in the ovary.

Fluctuations in Output

Considering the fluctuations in hormone output which occur even in the normal individual, the desirability of estimating gonadotrophin excretion on several occasions in the same person is obvious; its practicability in a laboratory undertaking a variety of hormone analyses is another matter. Since as a general rule the excretion of two hormones was ascertained in each patient, the data provided the clinician with a fair indication of pituitary function in doubtful cases.

Summary and Conclusions

1. A knowledge of the excretion of 17-keto-steroids and gonadotrophin is helpful to the clinician in dealing with developmental anomalies in children.

2. Gonadotrophin can be detected in normal girls before the seventh year, and in normal boys before the ninth year.

3. In children of both sexes in whom development was precocious, gonadotrophin was excreted in amounts considerably above the average for the chronological age. Precocious menstruation without a pathological background is probably associated with abnormal tissue response as well as premature pituitary secretion.

4. Cases are given illustrating the method of differentiating between precocity due to pathological, and that due to non-pathological causes by means of hormone assays.

5. The earliest age at which gonadotrophin was detected in urine was in a 'precocious' boy aged twelve months.

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TABLE 4

EXCRETION OF 17-KETOSTEROIDS AND GONADOTROPHIN IN ABNORMAL CASES: GIRLS

Case No.	Age in yrs.	Condition	17-ketostds., mg./24 hrs.	Gonadotrophin, M.U./24 hrs.
K339	2¼	Sexual precocity; m. twice; breasts and labia enlarged.	0·9 (1·2*)	<3; AZ-ve
K319	2½	Sexual precocity; m.; ovarian cyst; breasts enlarged.	3·15*	<4*; AZ-ve
P478	3 7/12	Sexual precocity; m. since 19 months old; breasts large; pubic hair at 2 mths.; ossific. = 12 yrs.	2·4 (5·6*)	AZ-ve; <4 I.U. oestrone
P409	4	Sexual precocity; m. and breast development = 17 yrs.; ossific. = 6-9 yrs.	2, 3, and 1·4	16; AZ-ve
K158	6½	Sexual precocity; m. for 3 mths.; breasts large; excessive body growth for 6 months.	4·1, 5·0	8; AZ-ve
K498	9 7/12	Sexual precocity; m. and breast enlargement; obesity (91 lb.), 52″ tall; ossific. = 12; pubic hair; striae; impaired sugar tolerance; enuresis.	3·0 (8·5*)	AZ-ve (excreting pregnanediol)
K172	11	Sexual precocity; m.; very marked breast development.	4·4 (3·5*)	12; AZ-ve
K299	3	Oversized = 5 or 6 yrs.; arms very long; hands and feet large; no pubic hair.	2·3	<1
K312	8	= 11 yrs. in devt. of mammae and limbs; 60″ tall, 92½ lb., abd. 29″.	2·2	7
K294	10	Obesity since appendicectomy 2 yrs. ago; weight 90 lb., 53″ tall; abd. 31″.	4·8 (10*)	22
K317	9 1/12	Developing quickly; pubic hair present for 1 year; axillary hair for 6 months; breasts slightly enlarged.	5·8 (10·5*)	13
K336	8½	Obesity 1 yr.; 6½ st., i.e. almost 3 st. above normal; 52″ tall.	4·8 (9·5*)	3 to 4
K350	13	Obesity—13 st. 6 lb., 'has always been obese.'	7·3 (11·9*)	almost 10
P516	6 3/12	Rapid enlargement of one breast.	5·4	AZ-ve
K303	2	Enlargement of one breast.	3·4 (10·5*)	<2; 5 cc. urine no effect
K340	7½	Leucorrhoea.	4·4 (6*)	<3
K321	8½	Dwarfism; 44″, 44 lb.; proportions normal.	2·8	<5
K326	9	Undersized: 40″, 43½ lb. (i.e. 10″ and 10 lb. less than normal); intelligent.	2·8	<3
K344	10½	Undersized: 6″ and 20 lb. under normal—of a small-sized family.	6·8	almost 7
K325	7	Virilism: v. large clitoris; growth of pubic hair.	28·7	<10; no pregnanediol
K355	15	Virilism.	28	not done
K139	3½	Virilism; enlarged clitoris, pubic hair; ossific. = 7-8; brother had adrenal tumour (K148).	12	„ „ no pregnanediol
K85	1 1/12	Virilism; enlarged clitoris; pubic hair (adr. hyperplasia).	23·5*	no pregnanediol
P323	3½	Virilism; enlarged clitoris, pubic hair (adrenal tumour).	5·9	12 mg. pregnanediol
K30	4	Virilism; enlarged clitoris, pubic hair (adrenal tumour).	375*	AZ-ve
K181	12	Virilism; enlarged clitoris, pubic hair (ovarian virilizing tumour).	116	55; 60 mg. pregnanediol

m. = menstruation. * = per litre of urine.

TABLE 5

EXCRETION OF 17-KETOSTEROIDS AND GONADOTROPHIN IN ABNORMAL CASES: BOYS

Case No.	Age in yrs.	Condition	ketostds. mg./24 hrs.	Gonadotrophin M.U./24 hrs.
K345	1	Physically and mentally precocious; walked at 4½ mths.	1·5 (4·5*)	Almost 7 ; AZ-ve.
P510	$1\frac{4}{12}$	Sexual precocity due to testicular tumour.	9·4*	AZ-ve
P519	5	Constitutional sexual precocity; enlarged genitalia, pubic hair; 10″ above average height; B.P.105/75.	7·5*	40-50
			5·0	AZ-ve
K263	6½	Sexual precocity (constitutional).	6·0	18, 21
			9·9	AZ-ve
K148	$10\frac{10}{12}$	Sexual precocity (adrenal cortical tumour).	84	not done
P512	$2\frac{5}{12}$	Neuroblastoma.	1·4 (4*)	,, ,,
		Sexual underdevelopment		
K292	8½	Lorain dwarf; =4 to 5 yrs.; iron callipers on feet for 2 yrs.	1·5	<2
K311	8	Dwarf; chronic diarrhoea 4-5 yrs.; Hb. 55%; tendency to bed-wet.	4·2	<3
K313	5⅓	Dwarf (36″; 32⅝ lb.); bed-wetter, diarrhoea for 2 yrs.; Hb. 70% (only 20 lb. <6 mths. ago).	6·4	<4
K316	10	Severe obesity (105 lb.); only 1 testis palpable (tiny); penis very small.	6·6	<3
K154	11	Severe calcium deficiency.	7·5	<4
K68	15	Diabetes; sexual underdevelopment.	2·3, 1·6	almost 4
K280	11	? Fröhlich's syndrome.	12·0	4-5
K173	12	Fröhlich's syndrome.	6·2	none
K170	14	? Fröhlich's syndrome.	10·0	10
K163	14½	Sexual underdevelopment, amyotonia, obesity.	7·4	not done
K233	15	Undescended testes.	8·0	7·5
K342	11	Gynaecomastia (unilateral, glandular).	7·0; 11·9	25 F.S.H. 5 L.H.
K122	8	Clitoris large; hypospadias; testes not palpable; brought up as female.	<2	20
K161	14	One testicle removed when 2½ yrs. old; vagina 1¼ inches long; clitoris size of red end of match; female type urethra; brought up as female; remaining testicle removed.	6·7	>106

*=per litre urine.

SOME MEDICO-SOCIAL PROBLEMS INVOLVED IN CHILD ADOPTION

BY

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In this communication it is proposed to outline some of the commoner problems of both medical and social importance in child adoption and to make some suggestions as to their avoidance or mitigation. The views are put forward in the light of several years of close contact, supervision, and medical care of infants and children, both before and after their adoption either through an adoption society or the local authority.

Social workers have always been puzzled to know why Britain, long noted for her enlightened legislation for the protection of the weak, had nothing on her Statute Book, until very recent years, which had been designed specifically to control child adoption.

History of Adoption Legislation

The case of Moses is an early example of child adoption, and ancient Babylonia, China, and the Roman Empire each had their laws to regulate and overcome two major problems in this connexion, viz., the problem of the childless couple desirous of having children, and that of the unwanted child. In the United States of America, the first adoption law was passed in 1851, and the dawn of the present century saw most European countries with legislative machinery for dealing with the adoption of children. In spite of Lady Mary Wortley Montague's lively interest in adoption in the eighteenth century, it only became a matter of Parliamentary concern in Britain in 1920, largely on account of the conditions precipitated by the world war of 1914-18. This agitation, rapidly increasing, culminated in the passing of the Adoption of Children Act on August 4, 1926, based on the recommendations of the Tomlin Committee. This Act applied only to England and Wales, an Act for Scotland being passed on August 1, 1930. As a result of these two Acts, child adoption was, for the first time, put on a proper legal basis in Britain.

The following brief summary covers the main provisions of these two Acts. The Acts enable single persons or a married couple only to adopt a child legally through specified courts. In the case of married couples, the application to adopt must be signed by both spouses. The child to be adopted must be under twenty-one years of age and unmarried, and the adopters not less than twenty-one years older than the child. The natural parents or legal guardians of the child must give free consent to the adoption. After full investigation of all facts relative to an application to adopt a child, the court, if satisfied, grants an Adoption Order authorizing the applicants to adopt that child. On the granting of an Adoption Order, all legal responsibilities of parent to child and vice versa pass from the natural to the adopting ones, with the exception of inheritance of property. In this case, the child still has the claim, in law, that it would ordinarily have on its natural parents, but it has no claim on the estate of the adopters, unless such claim is expressly stated and designated by name in their wills; the mere terms ' my child ' or ' my issue ' in a will do not cover an adopted child. The Registrar-General is required by the court to enter the new surname and christian names chosen by the adopters of the child in a special register, the Adopted Children's Register, and a certified copy of this entry may be used in lieu of a birth certificate. No financial transactions must be contracted between natural parents and adopters without the consent of the court.

The Adoption of Children (Regulation) Act, 1939, which, owing to the war 1939-45, did not become operative until June 1, 1943, was based on the recommendations of the Horsburgh Committee. Under this Act, all societies dealing with child adoption have to be registered with the local authority. They cannot practise for gain, and their activities are subject to close scrutiny. A probationary period of three months is required after the child has been placed with the prospective adopters, before any application can be made to the court for an Adoption Order. Adequate medical certification of each child is essential, and the society is required to receive back any child unsuitable or unsuitably placed for adoption. Private individuals who assist in placing children under nine years of age with adopters are required to notify the local authority at least seven days before the transfer of the child to the adopters. The local authority must then arrange for the supervision of the child by its child protection visitors until either an Adoption Order is made or until the child attains the age of nine years. If the

intending adopters, already having the child in their possession, change their residence, the local authorities of the areas of both existing and future residence must be notified at least seven days before the change of address takes place. Advertisements purporting to deal with child adoption are made illegal.

Such legislation, though not devoid of many loopholes, was long overdue, since, before legalized adoption, children were exposed to the gravest dangers. For example, a child well received into an adopter's household might be claimed later by the mother, sometimes for improper purposes. On the other hand, a child might be disposed of by the mother to an individual who offered her money; and, after that person's whim had been satisfied and the child tired of, it might be returned to the mother or to a charitable institution, frequently in a damaged state, or it might even be re-adopted with a further monetary transaction.

In discussing some of the problems encountered in adoption work, it must be re-emphasized that all the circumstances quoted below were encountered in the routine medical work associated both with an adoption society and a local authority. These problems will be considered under the three headings of : the mother; the adopters; the child. It must be borne in mind that reasonably satisfactory legislation is not in itself a sufficient safeguard unless it is backed up by an intelligent and sympathetic administration.

The Mother

The mother who wishes to have her child adopted must, on application to the local authority or adoption society, be interviewed. Invariably the child is illegitimate, and the prospects of the mother being able to look after it negligible or absent. The mother's reasons for wishing to have the child adopted must be carefully scrutinized, and every effort made to persuade her to keep her child if her future prospects are reasonably good, or if some arrangements can be arrived at for the care of the child till the mother is in a position to do so herself. Second and subsequent illegitimate children for adoption should be viewed with caution, and only rarely should such cases be accepted.

A careful medical history of the mother is essential, with, naturally, special reference to hereditary disease on either the maternal or paternal sides, if this last is known. If there is any history at all suspicious, there should be no hesitation in rejecting the application forthwith.

A complete medical examination of the mother is very desirable, though legally this is not compulsory. This examination may be carried out during the ante-natal period, or at the time of application for adoption if this is subsequent to the birth of the child. A blood Wassermann and Kahn test should be insisted upon, and with the more widespread application of mass radiography the chest might profitably be examined also.

The social worker who interviews the mother on behalf of the local authority or adoption society must see that the mother appreciates the loss of control of her child should it be adopted, and the mother is required to read and to sign a memorandum stating that she realizes fully the step that she is about to take. A point of paediatric interest might be mentioned here, viz., the folly of allowing a mother who proposes to have her baby adopted to nurse the infant except during the neonatal period, for the maternal tie may become so strong that either she is left a broken, frustrated woman when the infant is taken from her, or else she decides to keep the child for which she can never provide.

The Adopters

Adopters, on application to the local authority or adoption society, must be interviewed and must give their full reasons for wishing to adopt a child. In most instances the childless state of the prospective adopters is due to medical or surgical reasons. The sole reason for wishing to adopt a child should be love of children, and this cannot be emphasized strongly enough. Great care must be taken to ensure that the proposed adoption is not being tried in an effort to patch up a disintegrating marriage in the hope that the child may remedy a deeper defect. Steps must be taken also to confirm that the adopters appreciate their obligations and duties towards the child, and this, of course, includes reasonable surety of economic security and social responsibility. References from people of standing and integrity, usually in the place of domicile of the adopters, are required. The home of the adopters must be visited by a responsible official, frequently a health visitor experienced in such work, who reports on the medico-social and suitability aspects. There is usually some reluctance to accept the single adopter, though the law permits this to be done. As yet there is, unfortunately, no legal obligation to obtain a medical certificate of fitness of the prospective adopters. Legislation on this aspect is urgently required, but enlightened local authorities and adoption societies may insist upon this, and may consider no such application unless it is accompanied by a certificate of medical fitness. The prospective adopters' medical adviser would be in a position to furnish a confidential assurance that the family history did not show any hereditary or constitutional disability.

The Child

In dealing with the child, the paediatrician has a vitally important function to fulfil. Because adoption is a life plan, not just one for babyhood, his judgment must be carefully weighed. On his recommendations depend not only the future happiness of the child, but also that of the adopters, and the passing of a child as fit for adoption cannot be lightly undertaken. All his paediatric knowledge is required if he is to be successful in his recommendations that the child is mentally and physically

fit for adoption. The examination of the child must be full and complete, and, where possible, the natural parent should be present so that a full medical history (including the obstetric one) may be obtained, and every precaution taken to exclude those children with any suspicious history of hereditary disease or of disease in earlier life which might have left residua. Wassermann and Kahn tests should be carried out in all cases, even as confirmatory to these carried out on the mother's blood.

No child can possibly be passed as fit for adoption as a result of a first examination only. The child must be subjected to frequent observation, and this obtains particularly in respect of mental development, since, as is well known, this follows a fairly well-defined age pattern. Thus, motor, adaptive, language, and personal-social behaviour are subject to observation (Gesell and Ilg, 1943). As most of the children for adoption are infants seen a short time after birth, this observation period is all the more important.

A word might be said about the ' baby home ' in which the period of observation is passed. These homes, run in conjunction with adoption societies and suitably supervised, should be small units with modern equipment and a high staff/child ratio, so that the infants may receive the individual mothering and interest which they have lost from the breaking-off of continuity with their mothers. As Gesell remarks, it is too easy to forget that the infant has a psychology, and our methods of care affect the mental as well as the physical welfare of the infant. The routine, impersonal as it may frequently be, the hurried attitude of a harassed and too often inadequate staff such as might be met with in larger homes, does not give the child the chance to progress steadily forward.

The paediatrician's interest in the child does not cease after it has entered the adopters' household, and by his wise advice and supervision he may avert breakdowns between the child and the adopting parents. The adoption situation is new both to the adopters and the child, and the reactions of both to the situation created must be handled with care and toleration. The advent of the child into the adopters' home in most instances will, after the initial ' labour ' pains are over, result in untold happiness to all concerned. Two quotations from recent letters may be of interest as indicating the new atmosphere introduced into the home where the love of children prevails:

' We are indeed lucky. She is just a joy and so healthy and full of energy.'

' Of course we think she is wonderful, and cannot imagine what we did without her. She is very bright and lively and thoroughly enjoys life.'

Advice to adopting parents regarding the selection of a child to adopt is a very difficult problem. Happy indeed are the child and adopters who take to each other at their first meeting. Yet this happens so often that one is constrained to wonder whether the paediatrician should ever exert any direct influence on the prospective adopters in the choice of a child. Where the child has been observed in a baby home for some time, and the adopters are known to the paediatrician, he may offer advice on their choice, but generally it is preferable for him to take a relatively small part in the actual choosing of the child. His co-operation should be restricted chiefly to the medical examination of the child.

The problems which have just been discussed are those which are likely to be encountered in everyday adoption work. No attempt has been made to cover the whole field.

Summary

Child adoption has been known to occur in civilized countries from early times, but its legal control in Britain was instituted for the first time only in 1926.

The main clauses of the three Adoption Acts in operation in Britain have been briefly quoted.

Some of the commoner medico-social problems met with in adoption practice are considered under the three headings referable to the mother, the adopters, and the child.

I wish to express my thanks to Dr. W. G. Clark, Medical Officer of Heath, and to Dr. T. Y. Finlay, Maternity and Child Welfare Medical Officer, Edinburgh, for their kind help and criticism in the preparation of this paper.

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ABSORPTION COLLAPSE IN PRIMARY TUBERCULOUS INFECTION IN CHILDHOOD

BY

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Childhood tuberculosis has been the subject of much study during the past two decades, and a flood of light has already been thrown on to the life history of the disease. At the present time the conception of the primary lung complex is generally accepted. The inhaled tubercle bacilli find their way via the bronchi and bronchioles to an area in the lung just below the pleural surface. Here there is set up an area of bronchopneumonia varying in size from a grain of rice to a walnut. Drainage from this primary focus takes place via the peribronchial lymphatics to the regional lymph glands, and the term 'mediastinal tuberculosis' was at one time used to designate this condition. Routine tuberculin skin tests and recording of temperatures such as were undertaken by Wallgren (1935) show that this initial infection is usually accompanied by some degree of fever and malaise attributed to allergy, although clinical and radiological examination does not often reveal anything abnormal. A high erythrocyte sedimentation rate and a positive tuberculin skin test in a young child, however, indicate the necessity for care and continued observation. A follow-up of such positive reactors has revealed a varied course. By far the greatest number proceed to healing with no untoward episodes. Certain phenomena occasionally appear which are regarded as due to allergy, namely, erythema nodosum and phlyctenular conjunctivitis. Pleurisy with effusion, it has also been suggested, belongs to this category, although positive evidence of this is lacking. It seems not unlikely that this condition may arise occasionally, in older subjects at least, from infection of the pleura by the tuberculous process. We shall not discuss this further. Bronchogenic spread producing tuberculous bronchopneumonia, especially in infants, and haematogenous spread producing miliary tuberculosis and tuberculous meningitis in older children, are well recognized and with rare exceptions end in death within a relatively short time.

In addition to the above there also occur in children passing through their primary tuberculous infection extensive radiological signs of mischief in the lungs in the absence of any marked degree of toxaemia. The clinical picture accompanying these findings, and the course of the condition, were outlined by Eliasberg and Neuland (1920), and to it they gave the name of epituberculosis. It has been suggested that the extensive shadow seen in the radiograph is produced by the toxins in the lung tissue adjacent to the primary focus, that is, that it is a perifocal reaction such as occurs in the vicinity of any inflammatory focus, e.g., a furuncle. This conception gained in popularity, and it appeared a plausible theory. Such patients usually progressed to recovery, however, and the critical test, namely, the histology of the affected lung, was seldom available. That the lesion is a tuberculous bronchopneumonia caused by tubercle bacilli of low virulence has also to be considered, but its frequency and good prognosis would seem to be strong points against such a theory. Moreover, it does not behave as bronchopneumonia. The third suggestion is that such lesions can be explained by the pressure effects of the tuberculous regional lymph glands on the adjacent bronchi producing various degrees of occlusion, which in turn leads to collapse of the corresponding lobe or sector of a lobe (absorption collapse). This communication is presented with the object of providing evidence in favour of this latter theory.

Clinical Manifestations

The clinical material consists of a series of forty-five cases admitted to the Royal Hospital for Sick Children, Glasgow, since 1939. Not all of the cases seen are included in the series, as some were not admitted for full investigation and others were not available for re-examination. In all cases the investigation included a family and personal history, a clinical examination, Mantoux and Pirquet tuberculin skin tests, estimation of the erythrocyte

sedimentation rates, and radiography. In many the gastric residue was examined for tubercle bacilli by direct smear and by guinea-pig inoculation. In later cases lipiodol bronchography and bronchoscopy were used to determine the presence of the bronchial occlusion as well as its nature and degree.

A study of the clinical findings reveals that, although a diagnosis of tuberculous infection could be confirmed in every case by the presence of positive skin tests, the clinical signs were rarely such as to enable an accurate diagnosis of absorption collapse to be made, or for it to be possible to discover with any accuracy which lobe or sector was airless. In only nineteen cases were local signs detected clinically, such as impairment of the percussion note, bronchial breath sounds, diminished air entry, or scanty râles, and these signs were never so marked as to justify more than a suspicion that absorption collapse had occurred, save in five cases where clinical evidence of mediastinal displacement confirmed the true cause of the signs. However, now that the true nature of these cases is recognized by us, the finding of minor localizing clinical signs in a child not acutely ill and with positive skin tests is regarded as indicating with little likelihood of error that further investigation will demonstrate the presence of pulmonary collapse. The diagnosis is thus made by a process of deduction from past experience and from the knowledge of the pathological course often pursued by primary tuberculosis, and is not based on the physical signs alone, which, as stated, do not by themselves justify any such clearly defined diagnosis. As experience and insight into this pulmonary complication has been acquired, we have come to regard another clinical sign seen in fifteen of our cases as being strongly suggestive evidence of pulmonary collapse, although its tuberculous nature of course depends on the presence of positive skin tests. We refer to those cases in which a history is obtained of asthma-like breathing, wheezy breathing, or spasms of nocturnal cough with respiratory distress; or, alternatively, in which auscultation reveals the presence of rhonchi over one lung without the other accompaniments of bronchitis or asthma. So characteristic, indeed, is this picture, that we now believe that the appearance of ' asthma ' in an infant under the age of two years, especially in the absence of a family history of allergy, should arouse a suspicion of tuberculous hilar adenitis with some degree of bronchial occlusion, and that this suspicion should be abandoned only after adequate investigation, including radiography and tuberculin skin testing. The significance of this syndrome of ' asthma ', ' pertussis-like ' cough, noisy breathing, wheezing, ' musical rhonchi ' in bronchial narrowing, has been recognized by previous authors (Jackson, 1930; Macpherson, 1939; Jones et al., 1942; Kent, 1942; Meneghello and Smith, 1943).

As regards the constitutional upset, it seems probable that the occurrence of collapse is associated with some fever and mild toxaemia in all or most cases, but in a few there was an acute initial illness with brisk fever, malaise, listlessness, anorexia, and infrequent dry cough. Loss of weight was the rule, but it was only marked in a few cases, especially in infants. In two of our forty-five cases there was concomitant erythema nodosum, and two others had pleurisy with effusion before the occurrence of the absorption collapse. It must be stressed that the occurrence of pulmonary collapse may often be attended by such minimal upset that neither the child nor his parents are in any way concerned by it. The history of some of our cases suggested that the collapse had existed for six months previously, during which time the patients' activities were little curtailed. Undoubtedly many children with a primary tuberculous infection complicated by pulmonary collapse pass through the complete illness unsuspected, and it is probably from this type of case that bronchial stenosis or uninfected upper lobe bronchiectasis discovered by routine examination arises.

For example, Lightwood and Wilson (1936) describe the case of a boy who three years previously had had an illness diagnosed as pneumonia. Five months before coming under their care he had another attack followed by a cough with a little sputum and some breathlessness, but no malaise or fever. The tuberculin skin tests were positive. Bronchial stenosis was demonstrated both by lipiodol bronchography and by bronchoscopy. The lung was removed and was found to be shrunken and fibrous (absorption collapse), and to contain numerous areas of calcification.

There is in our wards at the present time a somewhat similar case with bronchiectasis of the right middle lobe, where bronchoscopy and bronchography revealed a bronchial stenosis, the opening into the right mid-lobe bronchus being greatly constricted.

Source of infection. A history of contact with open pulmonary tuberculosis was obtained in seventeen of the forty-five cases. Contrary to expectation, the frequency of such a history was not greater in younger infants than in older children. Because of the smaller circle of contacts of the young child it seemed reasonable to suppose that the younger patients probably get infected from near relations or frequent household visitors.

Radiographic signs. Radiography was carried out in every case, and was frequently repeated over long periods in some. It was always possible with antero-posterior and lateral films to localize the area of collapse with fair accuracy. The incidence of lobes affected was as follows:

Right upper lobe	10
Right middle lobe	13
Right upper and middle lobes ..	1
Right lower lobe	4
Right upper and lower lobes ..	1
Right upper and left upper lobes ..	1

Left upper lobe	7
Left lower lobe	7
Left upper and lower lobes ..	1

The right upper and/or middle lobes were affected in twenty-six cases (57·8 per cent.); the left upper and/or the left lower lobes were affected in sixteen cases (35·6 per cent.). The right lower lobe was the least likely to be affected. These figures agree closely with those of Jones et al. (1942), and have been explained on anatomical grounds by Brock et al. (1937), who point out that because of their anatomical relationships the left tracheo-bronchial group of glands are much more likely to obstruct the left main bronchus than are the right tracheo-bronchial group to interfere with the right bronchus. The explanation of the frequency of right upper and middle lobe collapse is that the broncho-pulmonary gland lying inferior to the eparterial bronchus in the angle between it and the right main bronchus is likely to distort and obstruct the entrances to the right upper or mid-lobe bronchi.

Radiographic appearances of pulmonary collapse are not difficult to recognize as a rule, although it is our experience that these shadows are frequently misinterpreted. This was no doubt a factor which lent powerful support to the view that they might be associated with allergy as a perifocal reaction. The antero-posterior and lateral appearances of collapse have been well described by Erwin (1939). Radiological evidence of mediastinal and/or tracheal shift to the affected side was found only in seventeen of our forty-five cases. Other classical signs of collapse, such as elevation of the diaphragm or 'crowding' of the ribs, were not seen in any case. These findings are in agreement with those of Kent (1942), and Jones et al. (1942), and the last-named authors point out that the comparative infrequency of these signs of collapse is to be attributed to the fact that when the bronchial lumen is occluded gradually (as in a slow process like tuberculous hilar adenitis), and especially if parenchymal tuberculosis is present in the affected lobe or sector, adjustments are made and the outpouring of fluid into the tissues may be more rapid than the absorption of air, so that the volume of the lobe may be as great as, or actually greater than, that of the normal lobe. Such a filled or 'drowned' lobe is not atelectatic in the true sense of 'imperfect expansion', although its aerating surface is as inadequate as an unexpanded lobe; thus the term 'absorption collapse' more accurately describes the condition of lung tissue distal to the seat of bronchial occlusion, whether its volume be greater or less than normal.

It was not possible to follow all the forty-five cases for long periods. Some cleared completely and a few showed extensive calcification not only of the hilar glands, but within the substance of the collapsed lobe. Whether this peripheral calcification represented healing of broncho-pulmonary glands, peribronchial lymphatics, or the primary lung focus itself, it is difficult to say. In some cases the collapse shifted from one lobe to another from time to time, and in others the extent of the shadow of collapse in one lobe varied in size and position from time to time. This irregular behaviour of collapse, due to gradual and often partial bronchial occlusion, e.g. from extrinsic pressure by enlarged glands, is not surprising. Thus at one time the narrowed bronchial lumen may become completely obstructed by sticky mucus which may later be expelled by coughing or postural changes and permit partial re-opening of the lumen for a time. Again, if a main bronchus be narrowed and the mucous membrane swollen and inflamed, the secretions therefrom may occlude the entry to an upper-lobe bronchus at one time and the entry to a lower-lobe bronchus at another.

Obstructive emphysema. The presence of partial bronchial occlusion may also, on occasions, produce the opposite of absorption collapse. Thus, partial obstruction by extrinsic pressure associated with a swollen hyperaemic mucous membrane may allow the entry of air to the alveoli distal to the site of the bronchial narrowing during inspiration, when the bronchi normally dilate slightly, but during expiration the slight narrowing of the bronchus may result in complete obstruction at the narrowed part of the lumen so that the exit of air cannot take place. This causes ballooning of the air-spaces, known as obstructive emphysema. This mechanism was first described accurately by Chevalier Jackson (1930). The radiograph of obstructive emphysema shows an area of increased translucency with possibly displacement of the mediastinum to the opposite side. Obstructive emphysema was seen twice in this series (cases 4 and 6). In case 4, the emphysema might have been compensatory to right upper lobe collapse, but the bronchogram showed marked narrowing of the right main bronchus. In case 6 the affected lobe had previously been collapsed. Meneghello and Smith (1943) in a series of fifteen cases showing bronchial obstruction, described obstructive emphysema in seven.

Bronchiectasis. In four of our cases of absorption collapse, bronchiectasis developed while they were under observation and, although the bronchiectasis was extensive in every case, it was outstandingly free from signs of secondary infection; thus, none of these children had any appreciable amount of sputum, there was no cachexia, and the appetite and general well-being were good. It is our impression that although bronchiectasis may be a not uncommon sequel to tuberculous pulmonary collapse in childhood, it seems to remain uninfected at least for many months. We would agree with Kent (1942), who described seven cases of bronchiectasis out of a total of ten cases of tuberculous bronchial obstruction, that changes of this nature do not play an appreciable role in the etiology of infected bronchiectasis. Uninfected bronchiectasis, often of an upper lobe, is a clinical phenomenon known to every chest physician. It is tempting to suggest that such a case often arises from a tuberculous collapse occurring during childhood.

Bronchography. Lipiodol bronchography entails certain disadvantages in tuberculous infection because the lipiodol tends to persist in small amounts for a long time afterwards and often makes interpretation of subsequent x-ray films difficult. Bronchography was performed in seven cases in the present series in an attempt to obtain further evidence that there was, in fact, bronchial obstruction. This was successfully proved. In three cases an upper-lobe bronchus was shown to be completely occluded just distal to its origin, and in one of these cases marked constriction of the main bronchus was also revealed (case 4). In two cases the main bronchus leading to a collapsed right middle lobe was shown to be narrowed, distorted, tortuous, and to fill irregularly and poorly with lipiodol. In one of these cases the lateral division of the right middle lobe bronchus was completely occluded; in the other, both lateral and medial divisions were abruptly occluded just distal to their bifurcation from the main middle lobe stem. In the remaining two cases the bronchogram was taken to confirm the presence of bronchiectasis suspected of being present because these children had suffered from collapse for many months. Cylindrical bronchiectasis was revealed in both cases, and in one (case 6) the main bronchus leading to the bronchiectatic lower lobe was seen to be much constricted in comparison with the bronchus on the other side.

Bronchoscopy. Bronchoscopy has only recently been employed, and five cases of this series have been so examined. In two, a main bronchus was much narrowed by extrinsic pressure. In another (case 5) extrinsic narrowing was associated with ulceration and granulation tissue in the bronchial lumen. In the fourth case, one of right mid-lobe collapse, the entry to the mid-lobe bronchus was much narrowed by swollen hyperaemic mucous membrane which bled easily and a smear from which revealed tubercle bacilli. In the fifth case, that of an infant (case 1), bronchoscopy failed because of narrowing and kinking of the trachea, possibly from paratracheal adenitis.

Four cases have come to necropsy. In none of these had bronchoscopy been carried out. In one, that of a three-month infant, the clinical diagnosis of collapse was confirmed (case 7). This child died of tuberculous bronchopneumonia. The three other children died of tuberculous meningitis at the ages of six months, eleven months, and two years respectively, but unfortunately the necropsy records are incomplete. Several case-histories of individual patients are detailed, illustrating various points already outlined.

Case Reports

CASE 1. A boy aged nine months was admitted to hospital on Aug. 29, 1946. He was a full-term healthy infant of healthy parents, breast-fed for eight months and given cod-liver oil and orange-juice regularly. He thrived until the first week in June, 1946, when he developed wheezy, difficult breathing which persisted until the time of admission. In the three weeks before admission the breathing had become 'panting,' with drawing-in of the chest wall. He had lost weight slowly from the age of six months. There was no cough.

On examination he appeared to have lost weight, and he was, in fact, only 74 per cent. of the expected weight for his age. There was no pyrexia, finger-clubbing, or cyanosis. Breathing was distinctly laboured, with marked recession of the chest wall at the level of the diaphragm with each inspiration. Local signs included rhonchi heard over both lungs with prolongation of expiration. The heart sounds were best heard to the right of the sternum; the apex beat was not palpable. The spleen was enlarged one finger's breadth below the costal margin. The Mantoux and Pirquet tuberculin skin tests were strongly positive. Films of the gastric residue revealed tubercle bacilli. The cerebrospinal fluid was normal. The radiograph showed collapse of the right upper lobe with mediastinal displacement of such a degree as to produce dextrocardia. Bronchoscopy was attempted, but failed because the trachea was markedly narrowed by a bulge on the posterior wall and kinked to the right by the enlarged paratracheal glands. He was discharged home to the care of his family doctor on September 8, 1946.

CASE 2. A girl, aged six years, was admitted to hospital on May 30, 1946. There was no family history of tuberculosis. She was a full-term healthy infant, breast-fed for four months and then fed on cows' milk with irregular vitamin supplements. She throve and developed normally. She had an attack of uncomplicated measles at one year. One month before admission she lost her appetite and became pale, listless, and easily tired. She was 'feverish' at night. There was no cough.

On examination she appeared reasonably healthy and was 91 per cent. of the expected weight for her age. There was no fever, cyanosis, or clubbing. The Mantoux and Pirquet tuberculin tests were strongly positive. The percussion note was unchanged, but there was slightly defective air-entry over the right upper chest. The sedimentation rate was 65 mm. in the first hour. Films of the gastric residue did not reveal any tubercle bacilli. The radiograph (Plate Ia) showed collapse of the right upper lobe. The lipiodol bronchogram on June 11, 1946, showed a complete block of the right upper-lobe bronchus just distal to its origin (Plate Ib). She was dismissed to be nursed at home on June 22, 1946. The radiograph on July 18, showed partial re-expansion of the right upper lobe and a new collapse of the right middle lobe.

CASE 3. A boy aged 12½ years was admitted to hospital on July 6, 1946. There was no family history of tuberculosis. He had been a full-term healthy infant fed on Nestle's milk. He had had measles at three years, pertussis at four years, and scarlet fever at nine years. He had been well until July, 1945, since when he had had frequent colds,

had been very listless, and had lost weight steadily. There was no cough except during the 'colds.' He was unduly breathless on exertion.

On examination he was found to be a pale, thin child, 75 per cent. of the expected weight for his age. There was no fever, cyanosis, or clubbing. The Mantoux and Pirquet tuberculin skin tests were strongly positive. The blood sedimentation rate was 25 mm. in the first hour. There was a small area of dullness on percussion to the left of the manubrium sterni, and the breath-sounds were harsh all over the left lung. The radiograph showed collapse of the left upper lobe with marked shrinkage, and emphysema of the left lower lobe. The lipiodol bronchogram on July 10, 1946, showed complete block of the left upper lobe bronchus just distal to its origin. Bronchoscopy on Aug. 5, 1946, showed that at the level of origin of the left upper bronchus there was a large bulge in the posterior wall of the left main bronchus reducing its lumen by two-thirds. The mucous membrane over this bulge was swollen and hyperaemic but appeared intact. Films of mucus from this area did not reveal tubercle bacilli. On Aug. 29 the radiograph showed complete re-expansion of the left upper lobe.

CASE 4. A girl aged six and a half years was first admitted to hospital on March 17, 1946. There was no family history of tuberculosis. She was a full-term healthy infant, fed on Ostermilk and given vitamin supplements. She had had measles at three years, chicken-pox at four years, and pertussis at four and a half years. In mid-Dec., 1945, she had an attack of abdominal pain with fever which subsided quickly. Three weeks before admission she developed a cough which has persisted. The cough is worse at night, associated with breathlessness, and followed by a spell of wheezy, noisy breathing. On March 14 she had an epileptic fit. She had been feverish for some days before admission and had lost much weight.

On examination she appeared pale and ill, but was 89 per cent. of the expected weight for her age. The cough was loose. There was no dyspnoea, cyanosis, or clubbing. The rectal temperature was 101° to 102° F. for some days after admission. The Mantoux and Pirquet tuberculin tests were strongly positive. There were abundant rhonchi over both lungs 'as in asthma.' The blood sedimentation rate was 60 mm. in the first hour. Antero-posterior and lateral radiographs showed the appearances of collapse of the subapical and pectoral axillary segments of the right upper lobe (Brock, 1946). Owing to shortage of beds she was sent home on March 31, 1945, to complete rest in bed. On May 17 she was re-admitted from the out-patient department because the antero-posterior and right lateral radiographs (Plate Ic and d) showed the characteristic appearances of complete collapse of the right upper lobe, with the 'gull-wing' shadow of the lower border in the lateral view, and emphysema, presumably obstructive, of the right lower lobe. She did not appear more ill at this time, and she was afebrile. The blood sedimentation rate was 35 mm. in the first hour. The sputum was negative for tubercle bacilli. The lipiodol bronchogram on May 20, 1946, showed complete occlusion of the right upper-lobe bronchus (Plate IIe), and the lateral view showed marked narrowing of the right main bronchus with only a trickle of lipiodol passing through (Plate IIf). On June 9 she had another convulsion, and on June 17 she was dismissed home on phenobarbitone. A radiograph taken as an out patient on Aug. 13 showed re-expansion of the right upper lobe, which now had multiple bronchiectatic cavities. She seemed fairly well, and there was very little sputum. The mother allowed her to be up for part of the day, contrary to advice. She was re-admitted on Aug. 21, having had a high fever for three days with a frequent dry cough. She now appeared flushed, dyspnoeic, and acutely ill. The temperature was 102° to 104° F. and this persisted thereafter in the ward. The blood sedimentation rate was 30 mm. in the first hour, and the gastric residue contained numerous tubercle bacilli. Clinically the trachea was noted to be displaced to the right. The percussion note was slightly impaired over the right chest, but the breath-sounds were almost inaudible over all of the right lung, suggesting complete occlusion of the right main bronchus. Radiographs on Aug. 22, however, showed bronchiectasis in the right upper lobe and collapse of the right middle lobe. Because of the continued high fever she was given sulphamezathine, 0·5 g. four-hourly, from Aug. 23, and penicillin, 15,000 units intramuscularly three-hourly, from July 25 to Aug. 31, without any beneficial effect. Blood-culture, stool-culture and Widal reaction were negative. The leucocytes varied from 3,400 to 4,000 per c.mm. On Sept. 5 the dullness over the right back became marked, with distant amphoric breath-sounds. Blood-stained fluid was aspirated from the right pleural cavity. The protein content of this fluid was 4 per cent.; and the leucocytes were 75 per cent. lymphocytes, 20 per cent. polymorphonuclear cells, and 5 per cent. endothelial cells. At the time of writing she was going down hill rapidly, with continuous fever, cachexia, finger-clubbing, and frequent unproductive cough. The condition appeared to be a terminal tuberculous bronchopneumonia, which in our experience is a rare sequel to collapse at this age.

CASE 5. A boy aged six and a half years was first admitted to hospital on May 15, 1946. He had recently lived in the same house with an adult cousin later diagnosed as suffering from phthisis. He was a full-term six pound twin, healthy at birth, and fed on cows' milk. At the age of three weeks he was successfully treated for pyloric stenosis. He had whooping-cough at fourteen months, and measles in April, 1946. During the measles he had had an attack of severe abdominal pain and had not been well since, complaining of listlessness,

anorexia, and loss of weight. On May 15 he was seen by his doctor because of severe right-sided abdominal pain, fever, and vomiting, for which he was admitted to the surgical wards.

On May 18 he was transferred to the medical wards still complaining of abdominal colic, and with fever which continued for another eight days. There were no signs of intrathoracic disease. The Mantoux and Pirquet tuberculin tests were positive and the blood sedimentation rate was 45 mm. in the first hour. Because of these findings a radiograph was taken on May 20 which showed enlarged hilar and right paratracheal glands with a small opacity in the right upper lobe thought to be a primary focus. On June 3, when he was free from symptoms and afebrile, the radiographs showed a triangular shadow situated in the right upper lobe with its base at the right hilum, and the appearance of collapse of the lung sector supplied by the pectoral branch of the right upper lobe bronchus. At this time there was an impaired note in the right axilla. He was dismissed home on June 11. At the out-patient clinic on June 27, 1946, a radiograph revealed an extension of the area of collapse in the right upper lobe. (His twin was examined at this time, and the radiograph of his chest showed an area of collapse identical with that of his brother.) The patient was re-admitted to hospital on Aug. 15, 1946. The blood sedimentation rate was now 13 mm. in the first hour. No tubercle bacilli could be demonstrated in the gastric residue, and guinea-pig inoculation was also negative. On Aug. 27 the condition was unchanged in the radiograph, so on Sept. 1 bronchoscopy was carried out. There was marked narrowing of the lumen of the right main bronchus from extrinsic pressure. On the medial aspect of this bronchus was an area of ulceration, covered with a thin layer of granulation tissue which could not be grasped with the crocodile forceps. The opening of the right upper bronchus was almost obliterated by swelling of the minor carina.

CASE 6. A girl aged five and a half years was under observation in the out-patient department for three months. There was a history of past contact with two aunts and an uncle, all victims of open phthisis. She had been a full-term healthy infant, breast-fed for nine months. She had had whooping-cough in 1941, measles in 1942, and chicken-pox in 1943. In December, 1944, she had pneumonia, and since then had never really been well. She complained of tiredness, listlessness and lack of appetite. Three months before admission these symptoms became worse, with loss of weight and a loose frequent cough. The Mantoux and Pirquet tuberculin tests were positive. Radiographs (Plate IIg and h) on March 5, 1946, showed collapse of the left lower lobe with mediastinal displacement to the left, and the film taken on April 30 showed obstructive emphysema in the left lower zone, the heart having returned to the normal position (Plate IIIj). On May 16 there was a reappearance of the collapse of the left lower lobe and mediastinal displacement, and on June 4 obstructive emphysema was once again noticed; this time it affected the whole left lung, with the heart not displaced.

On admission to hospital on June 14, 1946, she was found to be 110 per cent. of the expected weight for her age. There was no clubbing or cyanosis. The Mantoux and Pirquet tuberculin tests were positive. The sputum was negative for tubercle bacilli on two occasions and by guinea-pig inoculation. The percussion note was dull at the left base, where after postural drainage a small area of bronchial breathing was discovered. Scanty râles were heard over the left base behind. A radiograph on June 25 showed collapse of the left lower lobe with the heart displaced to the left. The lipiodol bronchogram on June 28 (Plate IIIk) showed cylindrical bronchiectasis of the left lower lobe with marked constriction of the left main bronchus. At this time the child was in good condition, eating well, and coughing up only two drachms of sputum per day. She was discharged to a convalescent home on Aug. 5, 1946.

CASE 7. A girl aged three months was admitted to hospital on March 10, 1946, as an emergency. No history of contact with tuberculosis could be obtained at the time, although it was later discovered that the father had phthisis. She had weighed 5·5 lb. at birth, and had been healthy and breast fed until three weeks before admission, when the feed was changed to Sister Laura's Food. She had had a cough since three days old, but on Feb. 17, 1946, it became worse and the breathing was distressed, the condition being uninfluenced by the administration of sulphadiazine.

On examination she was found to be a desperately ill, marasmic infant, 65 per cent. of the expected weight for her age. She was cyanosed and dyspnoeic and had a loose, frequent cough. The Mantoux and Pirquet tuberculin tests were strongly positive. Sputum obtained from the back of the throat contained abundant tubercle bacilli. The percussion note over the lungs was resonant throughout, but the breath-sounds were diminished at the right base. Râles were heard over the right chest. The temperature ranged from 101° to 103° F. until death on March 16, 1946. The radiograph taken on March 13 showed the triangular shadow of collapse of the right lower lobe, with marked displacement of the mediastinum to the right. There was a diffuse mottling in the left upper zone.

Necropsy showed a generalized miliary tuberculosis. There was complete collapse of the right lower and middle lobes and the pectoral segment of the right upper lobe. Primary foci were found in the right lower and left upper lobes, both being surrounded by areas of caseous pneumonia. The right lower lobe bronchus was surrounded by a caseous broncho-pulmonary gland. Proximal to this the right lower and middle lobe bronchi were completely occluded by tenacious mucus. The bronchial occlusion in this case seemed to be due

to a combination of narrowing from extrinsic glandular pressure and obstruction from thick mucus produced by a hyperaemic mucous membrane.

Discussion

The suggestion that pulmonary collapse may be brought about by occlusion of bronchi by pressure of glands is not new. In 1850, Gairdner, writing 'On the Pathological States of the Lung Connected with Bronchitis and Bronchial Obstruction,' cites a case which is similar to those under discussion and which is so complete that it is deemed worthy of quoting. A child of five years of age died of tuberculous meningitis. At necropsy the primary focus, which was the size of a walnut, was found in the upper margin of the left lower lobe. The enlarged glands at the root of the left lung pressed upon some of the bronchi going to the left lower lobe, causing collapse of the anterior extremity of this lobe. In his article Gairdner says, 'I think the frequency of collapse of the pulmonary tissue both in the adult and in the child must now be considered as established and its connexion with bronchial obstruction rendered at least extremely probable.' He quotes several authors who had arrived at a similar conclusion (Louis, 1829; Alderson, 1831). Gairdner also quotes Carswell, who 'figured the case of a monkey in which the left bronchus was much compressed or rather obliterated by a mass of tuberculous glands.' The corresponding lung, he goes on to say, had diminished to less than a third of its normal bulk, while the opposite lung, of which the bronchus was free, presented emphysema in several places. At about this time, too, Mendelsohn and Traube had produced collapse experimentally in animals by occluding bronchi with lead shot and balls of paper.

This work apparently attracted little attention or was forgotten, and it is only within recent years that the importance of bronchial occlusion in the etiology of bronchiectasis and as an explanation of the collapse in the primary tuberculous infection has been recognized. Morlock and Pinchin (1933) were the first to describe bronchial obstruction due to tuberculosis which had been observed bronchoscopically. The subject was a boy of fourteen years in whom epituberculosis had been diagnosed. He had an 'asthmatoid wheeze' produced by right upper lobe collapse. On bronchoscopy, tuberculous granulation tissue bulging into the lumen of the bronchus and covered with normal mucous membrane was observed. After removal of the granulation tissue the radiograph cleared in four days. Similar cases have been described by Brock et al. (1937), Jones et al. (1942), and Kent (1942) among others. The alternative explanation of the etiology of the type of case under discussion, namely, epituberculosis, has been based on the papers published by Eliasberg and Neuland (1920, 1921). They regarded the dense shadows as being caused by non-specific pneumonia in a tuberculous subject, but Reichle (1933) suggested from the histology that the lesion was a tuberculous pneumonia without caseation. The popular conception of epituberculosis, however, is that the shadow, which appears either suddenly or slowly and then recedes gradually, is an allergic response around the primary focus. This is a very plausible theory, but, so far as we know, such a condition has not been described histologically in man, although Oppenheimer (1935) has produced a condition experimentally in animals which would seem to support the view that such an allergic response in lung tissue may occur. She produced a radiographic lesion like that of epituberculosis by the injection of dead tubercle bacilli into sensitized rabbits; no similar shadows appeared in the non-sensitized rabbits. Histologically the lesion is described as a 'typical tuberculous pneumonia,' but the course was one of regression and disappearance, leaving the animal unaffected.

However, all workers, including ourselves, who have set out to determine the true nature of the lesion in these cases have discovered evidence only of bronchial occlusion and collapse—by radiography, by bronchoscopy, and by pathological examination. It seems reasonable to conclude that, although primary tuberculous infection does produce spontaneous manifestations of allergy, such as erythema nodosum and phlyctenular conjunctivitis, epituberculosis is not one of these manifestations. Rather does its explanation rest purely on a well-founded and easily demonstrated mechanical basis.

It might be suggested that, in a child in whom a bronchus is occluded by a mass of tuberculous granulation tissue containing virulent tubercle bacilli, bronchoscopy is contraindicated, and that the removal of the tuberculous granulation tissue via the bronchoscope might be followed by a rapid spread of the infection and the death of the patient. However, such does not seem to be the case (Morlock and Pinchin, 1933; Brock et al., 1937; Jones et al., 1942; Kent, 1942; Meneghello and Smith, 1943). On the other hand, failure to bring about expansion of the collapsed lung may result in the development of bronchiectasis. Further observations on the final results obtained by bronchoscopy and removal of the obstruction compared with those not so treated are urgently required.

Summary

Absorption collapse of a lobe or sector of a lobe due to bronchial occlusion is of common occurrence

in the course of the primary tuberculous infection in children. In some cases of incomplete bronchial occlusion, obstructive emphysema may result.

The term 'epituberculosis' as applied to this condition is a misnomer, and the suggestion that the shadow seen in the radiograph indicates a perifocal reaction of an allergic nature is not justified.

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(For illustrations to this article see Plates I-III.)

CASE REPORTS

TWO CASES OF EHLERS-DANLOS SYNDROME

BY

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The Ehlers-Danlos syndrome is a congenital abnormality of the skin, of which the following may be considered the chief characteristics: (1) Abnormal friability of the skin and subcutaneous tissue ; (2) loose and hyperelastic skin ; (3) hyperextensibility of joints ; (4) the presence of nodules of various types in the skin ; (5) well-marked epicanthic folds.

The clinical picture is not invariably complete and, as in other congenital conditions, the incidence of associated congenital abnormalities is higher than in normal subjects. The friability of the skin is nearly always evident from the history of these patients. They are described as being subject to cuts or even large gaping wounds from the most trivial injuries, and a glance at the skin of their knees or foreheads will show scarring of an unusual degree. The laxity of the skin is easily demonstrable as a rule by the ease with which a fold may be drawn away from the deeper tissues, and its lack of attachment is suggested by the absence of skin creases which, according to Le Gros Clark (1945) are due to the attachment of the skin to deep fascia by strands of collagen fibres.

Observation of the wounds in these patients shows an unusual freedom of the fat lobules, which are easily detached from the wound surface, and it is noticed that when sutures are being placed in such wounds it is necessary to space them close together, owing to the marked degree of retraction of the skin between the sutures. There is an abnormal tendency in these patients to bruise easily, and this has been described as due to abnormal friability of the blood vessels. In fact, no abnormal histological appearance of the vessel walls has been described and it may well be that the cause of the vascular damage is due to lack of supporting tissue. There is no abnormality of the platelet count.

Hyperelasticity of the skin is demonstrated by the rapid return to its original unwrinkled state when tension is released. It may be mentioned that abnormal looseness of the skin can occur as an isolated abnormality unrelated to the Ehlers-Danlos syndrome, when it should be referred to as cutis hyperelastica.

Hyperextensibility of the joints is presumably due to an abnormality of the mesodermal tissue in the joint capsule analogous to that of the skin. It is not associated with any radiological alteration in the joints.

Nodules in the skin, which are described in the majority of these patients, are of two main types, though there appears to be some confusion in the terminology. The subcutaneous, freely movable nodules described by Parkes Weber and Aitken (1938) and Tobias (1934) appear histologically to be small lipomata.

The soft, raised thickenings of the skin which follow bruising are most probably due to organization taking place in the haematomata. Ronchese (1936) states that these nodules contain numerous foreign-body giant cells.

Marked epicanthic folds, which occurred in both our cases described below, have also been noted by Benjamin and Weiner (1943) and others, and could be included as one of the chief characteristics of the syndrome.

Pathology

Ronchese (1936) has described sections of the skin which reveal thinning and torsion of the collagen fibres, and Burrows and Turnbull (1938) found that the collagen bundles were less regularly arranged and less closely packed than in the normal subject. There appears to be an increase of elastic tissue, which is arranged in irregular and coarse bundles. The individual elastic fibres are rough, and tend to be curled up at the edges.

Case Histories

Case 1. A boy, aged three and a half years, weighed 27 lb. His mother stated that 'when he falls he doesn't cut himself, he just tears open,' and that he bruised very easily.

Case 2. A girl, aged nine years, weighed 51·5 lb. She has always bruised easily and on six occasions has suffered large cuts in her left knee.

Both patients had been frequent visitors to a hospital casualty department for suturing of superficial injuries. Their mental and physical development had otherwise been normal, and no abnormal physical signs were elicited other than those described. In neither case was there consanguinity of the parents, nor was there any family history of the condition. All the characteristic features mentioned above were present in both patients. Hyperextensibility of the joints was marked, and the girl was able to touch her heels with the back of her head, when supported, without effort.

The boy had numerous scars on both knees, forehead, and chin. The scars had the typical appearance described in this condition, being thin, papyraceous, and atrophic, and the epicanthic folds mentioned above were well marked. The bleeding time and clotting times, platelet counts, and tourniquet tests were all within normal limits in both patients.

The histological report on a biopsy specimen of the girl is as follows.

SECTION 1 (JUNCTION OF SCARRED AND NORMAL SKIN). The epidermis is atrophic and the corium condensed, resulting in narrow bundles of collagen disposed almost entirely in a horizontal plane. In one area there is a complete absence of elastin in the pars papillaris and subjacent superficial part of the pars reticularis.

SECTION 2 (NODULE). There is no appreciable pathological change.

SECTION 3 (SMALL ARTERY). The vessel wall is cut almost longitudinally, and is surrounded by loose areolar tissue into which there has been haemorrhage attributable to the biopsy.

Thanks are due to Dr. I. Muende for the histological report and to Mr. Derek Martin for the photographs.

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(For illustrations to this article see Plate VII.)

MEGALENCEPHALY: A REPORT OF TWO CASES

BY

JOHN APLEY AND MICHAEL SYMONS

(From the Departments of Medicine and Pathology, University of Bristol)

While there can be little doubt that megalencephaly is a rare condition, the degree of rarity is possibly exaggerated. In both the cases described below, seen within a week of each other, a mistaken diagnosis of hydrocephalus was made clinically, and without autopsy would have remained uncorrected. It seems quite probable that some cases of megalencephaly are erroneously labelled hydrocephalus, and with this diagnosis post-mortem examination is not uncommonly omitted.

Apart from the value of collating evidence in an uncommon condition these cases may throw some light on the mode of death in association with raised intracranial tension.

Case Histories

Janet G. She was an only child, with no relevant family history, and was born one month before the expected date, was slightly cyanosed at birth, and weighed 5 lb. 4½ oz. No note was made as to any cranial abnormality. From the first she did not suck well, and the gain in weight was unsatisfactory. At the age of six and a half months she was not yet attempting to sit up or grasp objects, and the head circumference was 19·5 in. (normal 17·3 in.). At nine months the head was described as 'hydrocephalic' and measured 20 in. in circumference. At one year she could not speak at all, moved her limbs very little, and was considered to be mentally defective.

PRESENT ILLNESS. At the age of one year she became acutely ill and for two days cried frequently, as if in pain, and did not sleep well. After the second day she vomited once. She was found by her doctor to have a raised temperature, head retraction, and a positive Kernig's sign.

On admission to hospital the temperature was 101° F., and the pulse and respiration rate were respectively 140 and 30 per minute. The head appeared large. The child gave the impression of not seeing properly, though she blinked at objects moved towards the eyes. The anterior fontanelle was widely patent and the forehead prominent. There was frequent twitching of the face, markedly on the right side. The child did not move her head or attempt to sit up, but the limbs moved and she could swallow. Kernig's sign was now indefinite, the deep reflexes were normal, and plantar responses flexor. The tonsils were enlarged and red, but routine clinical examination was otherwise unproductive.

Lumbar puncture was performed next day, and 10 c.cm. of fluid removed. The initial pressure of 165 mm. of water rose to 190 mm. with the Queckenstedt manoeuvre, and slowly fell again on releasing the pressure. Shortly after removal of the fluid, which was found to be normal, convulsive movements of face, arms, and legs occurred.

Later in the day the temperature, pulse, and respiration began to rise from 104° F. and 140 and 40 per minute, and by the next day had reached respectively 109·2° F., 170, and 50, when the child became collapsed and died.

POST-MORTEM FINDINGS. The body was well nourished and the only apparent abnormality was the large head, which measured 20 in. in its greatest circumference. The head was normal in shape and did not have the bulging appearance usually seen in hydrocephalus.

There was slight tonsillar enlargement. In the remainder of the body, apart from the skull and brain, no abnormalities were found. The sutures of the calvarium appeared firmly united but the bone was thinner than normal. The anterior fontanelle was widely open but not bulging; the other fontanelles were closed. The meninges appeared normal. The cerebral convolutions were not flattened, though there was a slight compression cone on the under surface of the cerebellum. The whole brain weighed 1,450 g. (normal for this age approximately 975 g. See Plate VIII, figs. 1 and 3). The increase in size affected all areas of the brain proportionately. The right cerebral hemisphere was sectioned at once and appeared microscopically normal. The ratio of white to grey matter was within the normal range, and the ventricular system was not dilated. The remainder of the brain was kept for histological study by Dr. R. M. Norman, who reported that he could find no apparent abnormalities in routine blocks from different parts of the brain. The spinal cord was not examined.

Autopsy diagnosis: megalencephaly; tonsillitis; pressure cone of cerebellum.

Linda B. Of this child's two siblings, one was premature. An uncle is said to suffer from attacks of petit mal.

PERSONAL HISTORY. Delivered normally at full term, she weighed 7 lb. 9½ ozs. at birth. The mother's age at delivery was twenty-three years, and the child was described as 'a healthy female baby.' At birth the head measurements were recorded as follows: circumference 13·5 in.; S.O.B. 3·75 in.; S.O.F. 4 in.; occipito-frontal 4·5 in.; M.V. 5·25 in.; S.M.B. 3·75 in.; B.P. 3·75 in.; B.T. 3·5 in. These figures are normal.

The child's early development showed no significant deviations from normal, but she is said to have been 'chesty' since the age of two months,

and at ten months had 'influenza' with running at the eyes and nose for a week. Subsequently she gained weight only poorly throughout the winter. One week before admission to hospital, at the age of fifteen months, she was given her first anti-diphtheria inoculation.

PRESENT ILLNESS. At this time the child was described as 'off colour.' Two days later a cough developed, and in a further two days she began to vomit most of her feeds. On the morning of admission to hospital a fit occurred, during which it was said that the eyes rolled up, the child was limp, then stiff, and then went 'black.' She came to when put into a hot bath, but a similar, rather milder, attack occurred a few hours later.

On admission the child looked grey and ill. She was dyspnoeic and grunted with each respiration. The throat appeared mildly inflamed. In the chest scattered rhonchi were audible, and there was doubtfully impaired resonance at the left base. The pulse rate was rapid, but the heart was considered to be normal. No abnormalities were detected in the abdomen. The anterior fontanelle was still widely patent. Apart from slight hypotonia there was no evidence of central nervous system involvement. The temperature was 100° F., the pulse 160, and the respiration 44. Sulphadiazine was prescribed. Vomiting occurred once on the day of admission.

Suddenly, on the next day, breathing stopped and the child became cyanosed and unconscious. All four limbs were then flaccid and the plantar responses extensor. In a few minutes, when breathing started, moist sounds were heard throughout the lungs. After half an hour the limbs became hypertonic. Consciousness was not fully recovered two and a half hours after this incident, when again breathing stopped for a few minutes. Marked cyanosis developed and the pulse became impalpable. At this time the child was flaccid, the pupils were small, and the plantar responses were still extensor. The temperature was 105° F., the pulse 200, and the respiration 40. Two and a half hours later a similar incident occurred, and lobeline was injected.

The presence of lesions in the lungs and central nervous system suggested a clinical diagnosis of miliary tuberculosis with meningitis, but this was disproved by cerebrospinal fluid examination. With therecent fatality (case 1) in mind, only a small amount of fluid was withdrawn, insufficient to permit measurement of the pressure; the fluid did not flow at an excessive rate and was clear. The Queckenstedt test was normal. Cerebrospinal fluid examination showed a clear colourless fluid containing one lymphocyte per c.mm., and protein and chlorides were respectively 35 mg. and 760 mg. per 100 c.cm.

Intramuscular penicillin injections were commenced. During the day the pupils gradually became pin-point in size, the eyes converged, and tremors developed in the eyelids and right arm. Twenty-one hours after the onset of the first attack in hospital breathing ceased again. Oxygen was given and artificial respiration applied, and breathing was resumed. Twelve hours later the temperature was 105·6 F., the pulse rate was too rapid to be counted, and the respiration rate had risen to 60 per minute. Soon after the child died.

POST-MORTEM FINDINGS. The only unusual feature was the large head, which measured 20 in. in its greatest circumference (normal 18·5 in.).

The only abnormalities in the viscera were a patchy bronchopneumonia affecting both lungs, and a congenital stenosis of the right pelvi-ureteric junction with dilatation of the ureter below this in its middle third. The sutures of the cranial vault were united and the bone was somewhat thinned. The anterior fontanelle was still widely open; the other fontanelles were closed. The meninges were healthy, but all the intracranial venous sinuses were markedly distended and congested.

The cerebral convolutions showed some flattening (Plate VIII, fig. 2) and the surface of the brain was dry. The whole brain weighed 1,770 g. (normal for this age approximately 960 g.). There was a proportionate enlargement of the entire brain, which showed no gross abnormalities. The ratio of white to grey matter was normal and the ventricular system was not dilated. Dr. Norman examined the brain histologically and reported that he could find no abnormality. The spinal cord was not examined.

Autopsy diagnosis: megalencephaly; congenital stenosis of the right pelvi-ureteric junction; bronchopneumonia.

Discussion

Definition of megalencephaly. The term megalencephaly was first used by Morley Fletcher (1900). As employed by Kinnier Wilson (1933) it is restricted to cases in which there is proportionate enlargement of the whole brain associated with some mental or nervous aberration. This usage eliminates those instances described by other authors in which the enlargement is disproportionate.

Pathology. Cases showing enlargement of the brain may be divided into two groups. In the first, into which our cases fall, there is a proportionate enlargement of the whole brain and, in the gross, all areas appear to be equally affected. The majority of cases are of this type. In the other, smaller group the enlargement of the brain is disproportionate and one part of the brain enlarges, as it were, at the expense of another; thus the cerebral hemispheres may be grossly enlarged and the cerebellum very small, or the ratio of white to grey matter may be abnormal. The histological picture is very variable in both groups. Appearances may be normal, as in our cases; or, at the other extreme, the enlargement is found to be due to a diffuse overgrowth of neuroglial tissue, the so-called gliomatosis. Between these examples are found many varying abnormalities of the brain tissue. There may be a slightly disproportionate increase of one element with normal appearances of the

tissues themselves, or, as in the case described by Kinnier Wilson (1933), the nerve cells may show abnormal staining reactions and morphology.

Although both the cases described here fulfil the essential criteria of megalencephaly, no histological changes could be found. It is unfortunate that we did not examine the spinal cords, as there does not appear to be any reference in the literature to the possibility of an associated enlargement of this part of the central nervous system.

Clinical aspects. Megalencephaly or hydrocephalus may be present at birth or develop later, so the time of onset affords no help in differentiation. In both conditions mental deficiency is also common. Meticulous clinical examination should, however, provide some guidance if megalencephaly is borne in mind. In this condition the maximum width of the head is at a level lower than in hydrocephalus (Stewart, 1936-37), in which it lies above the superciliary margin. Encephalography has enabled the diagnosis to be made during life in one recorded case (Brain, 1936).

Recorded cases of megalencephaly are so few that it remains unprofitable to draw conclusions as to prognosis. It seems likely that, in its milder forms, megalencephaly may be benign if a fatal issue is not brought about, as in the cases described, apparently in association with an acute infection.

Cause of death. In some of the recorded cases no details of the cause of death are given, but in many of the remainder death was comparatively sudden and associated with an acute febrile illness, in one instance pneumonia (de Lange, 1932), in another scarlet fever (Tsimenakes, 1902), and yet another 'following an infection' (Kinnier Wilson, 1933).

One of our two cases, Janet G., developed 'meningism' with tonsillitis. The compression-cone seen at autopsy appears to be consistent with the other evidence of increased intracranial tension. In the other case, Linda B., the neurological picture confirmed the impression that death was due to an intracranial disturbance rather than to the comparatively insignificant bronchopneumonia demonstrated post-mortem. The cerebrospinal fluid pressure was not measured in this latter case, in view of the unfortunate consequences attributed to this procedure in the former, but the autopsy finding of dry and flattened cerebral convolutions is evidence that intracranial pressure was raised.

If, in these two cases, death was due to a relatively sudden rise in intracranial tension, it is interesting to speculate on its possible cause. In the normal course of events, variation in the amount of cerebrospinal fluid in the cranium may compensate for a moderate increase in volume of the other intracranial contents; but in cases of megalencephaly it may well be that the margin of safety is too small for adaptation, so that any increase in quantity of cerebrospinal fluid or in brain bulk may lead to a fatal rise of intracranial pressure.

A relatively sudden increase of intracranial tension may result from various causes. In meningism an excess of dilute cerebrospinal fluid is formed, probably as a result of rapid dilution of the blood in acute infections and increased filtration through the choroid plexus from the relatively hypotonic plasma (Fremont-Smith and Merritt, 1937). In neither of our cases was there evidence of dilution of the cerebrospinal fluid, an essential feature of meningism, and only slight clinical evidence of the condition was found in case 1, Janet G. An increased secretion of cerebrospinal fluid would not, therefore, appear to be the explanation of the raised intracranial tension in our cases, but it may explain some sudden deaths. Another possible explanation would be acute cerebral oedema. In neither case was there any evidence of this post mortem.

A further possibility is that the sudden rise in pressure results from an increased amount of blood within the cranium. Cairns (1939) has described acute swelling of the brain and distension of the capillaries and venous channels following inhalation of carbon dioxide during anaesthesia, and it is perhaps possible that in some cases bouts of apnoea or asphyxia may have a similar effect as a result of a rise in the carbon dioxide content of the blood.

The cause of death is not adequately explained by this mechanism in our first case; but our second case, Linda B., had pneumonia with bouts of apnoea and cyanosis, and at autopsy one of the striking features was the marked distension of all the intracranial venous sinuses. It is a possibility that the final explanation given above may apply in this instance.

Summary

Two cases of megalencephaly are reported, with clinical and pathological data.

In both cases death was associated with an acute infection, and it is suggested that death was due to a sudden increase in intracranial tension. Possible causes leading to this rise in intracranial pressure are discussed.

We thank Prof. C. Bruce Perry and Prof. T. F. Hewer for their very helpful suggestions, and members of the staff of the Bristol Children's Hospital for permission to publish these cases. We are especially grateful to Dr. R. M. Norman for his reports on the histology of the brains. For the photography we are indebted to Mr. S. A. Edwards.

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(For illustrations to this article see Plate VIII.)

OSTEOMYELITIS OF THE MAXILLA IN INFANCY

BY

J. C. HAWORTH

(From the Children's Hospital, and the Department of Child Health, Birmingham)

Acute suppurative infection in infancy is of peculiar interest in the special clinical features according to (a) the bacteriology, and (b) the localization. Osteomyelitis is by no means a rarity in the early months of life. The staphylococcus is a prevalent micro-organism, and its mode of entry into the tissue is often difficult to trace; but fortunately a prompt cellular defence is rapidly mobilized, and, with the advent of chemotherapy and antibiotic remedies, recovery from such infection is now very much more hopeful. Acute osteomyelitis of the maxilla is an example; it may occur in the early weeks of infancy. During the past fifteen months five cases of this condition have been admitted to the Children's Hospital, Birmingham, and this short paper is a record of their progress.

The local anatomy is of some interest; the antrum is present at birth, and the superior maxilla is a highly vascular area of diploic bone, having as its upper boundary the lower border of the orbit, and extending down to the dental ridge containing the primordial follicles in which are embryonic teeth enclosed within a vascular bed. The infecting organism may gain entrance to the superior maxilla in a variety of ways: (1) from the adjacent maxillary antrum, which in infancy is always very prone to infection; (2) from the lachrymal duct and sac; (3) from a primary infection of the embryonic teeth follicles, which may occur from the blood stream or by trauma to the overlying gum occurring at, or soon after, birth. It is in the latter way that infection occurred in two of the following cases, as the infected dental radicle was removed surgically. This of course disturbs the primary dentition, and occasionally the permanent dentition may also be affected.

Jacoby and Sagorin have recently reviewed the subject and recorded the favourable progress in three cases. Their commentary on the treatment is important, especially in regard to the desirable minimal surgical attention, bearing in mind that the dental areas may suffer interference; also cosmetic effects must be kept in mind. These authors have noted the remarkable and rapid effects of penicillin in this particular disease; healing was obtained in one or two weeks, as compared with an illness of months' duration and high mortality with former lines of treatment.

Case Reports

Case 1. A male baby of four weeks, breast-fed, was admitted to hospital because three days previously the mother had noticed a swelling on the left side of his face and over the eye. There appeared to be some discharge from the eye and the nose on the same side. No diarrhoea or vomiting was present.

EXAMINATION. The baby weighed 5 lb. 9 oz. There was proptosis of the left eye, chemosis, and some purulent discharge from the lachrymal duct. The left cheek was reddened and markedly swollen, and gentle pressure caused a purulent discharge to come from the left nostril. A small sinus was discharging in the left alveolus. Temperature was 101° F., and the pulse rate 148 per minute.

TREATMENT. Penicillin, 1,500 units three-hourly, was given intramuscularly, and sulphadiazine, 0·4 g., followed by 0·2 g., six-hourly. The baby's condition improved, and forty-eight hours later a small incision was made over the left alveolus and a diseased tooth follicle was removed. A large amount of pus was evacuated, and the swelling appeared to diminish in size and become much less tense. Culture of the pus revealed a heavy growth of staphylococcus aureus. In a further forty-eight hours there was a vast improvement, and penicillin treatment ceased. In still another forty-eight hours the swelling of the face had disappeared; the baby could open and close the eye. Twenty-four hours later there was slight recurrence of swelling in the cheek below the left eye, and another twenty-four hours' course of penicillin was given, with the result that the signs of local infection completely subsided and the baby was discharged clinically well six weeks after admission. A total of 120,000 units of penicillin was given in the first course, and 156,000 units in the second course.

Case 2. A male baby, aged four weeks, had been ill for ten days before admission to hospital, the parents having noticed a swelling below the left eye for several days.

EXAMINATION. A small dehydrated infant, weighing 7 lb. 9 oz., had a firm smooth swelling in the left side of the face which seemed to involve the whole maxilla. This swelling extended into the mouth and the palate on the left side, where there was a small discharging sinus. There was marked conjunctivitis and chemosis on the same side. No diarrhoea or vomiting was present.

TREATMENT. On the date of admission free

drainage was established by opening into the left side of the palate and alveolus. Thick pus was released. Culture showed haemolytic staphylococcus aureus, and a few pneumococci. Intramuscular penicillin, 1,500 units three-hourly, was given over a period of five days, and penicillin was applied locally for a few days. The inflammatory swelling quickly subsided; the incision healed, and rapid clinical progress was made. The baby was discharged from hospital after a stay of fifteen days. A total dose of 96,000 units of penicillin was given over eight days.

Case 3. A male baby, aged seven weeks, who had been artificially fed, had had a septic finger during the first week of life, and a swelling below the left eye had developed ten days before admission to the Children's Hospital. The child was referred from the Birmingham and Midland Eye Hospital with a history of a left-sided nasal discharge and swelling of the left cheek and left upper alveolus. Penicillin had been given, and an incision made into the lower lid.

EXAMINATION. The baby was well nourished, weighed 7 lb. 12 oz., and had a temperature of 100° F., and a pulse rate of 130. There was a swelling under the left lower lid, and pressure over this area caused a blood-stained serous discharge to appear from the nostril. There was no diarrhoea or vomiting.

TREATMENT. An incision was made over the left upper alveolar labial fold, and thick pus evacuated. Cultures gave a heavy growth of staphylococcus aureus. Several small sequestra were removed. From the lateral nasal wall and the region of the zygoma one infected dental radicle was enucleated. Intramuscular penicillin was continued, 1,500 units, three-hourly, for six days. The baby made favourable progress and the swelling rapidly subsided. After seventeen days' treatment in the Children's Hospital the baby was discharged home clinically recovered and gaining weight satisfactorily.

Case 4. A male baby, aged twelve weeks, had been breast-fed for one month, and weighed 11 lb. 7 oz. Twenty-four hours before admission he became extremely fretful, and a few hours later it was noticed that the left eye was swollen, and this gradually became worse during the day. There was no diarrhoea or vomiting.

EXAMINATION. The baby was pale but well nourished, with marked oedema and swelling about the left cheek and eyelid; the left eye appeared partly proptosed and the conjunctival sac purulent. There was a sinus discharging thick pus in the upper left alveolar region, and also a purulent discharge from the left nostril.

TREATMENT. Penicillin, 20,000 units, was given intramuscularly three-hourly; this was later reduced to 8,000 units. Sulphadiazine was also given. On the same day the alveolus was opened up a little and pus allowed to escape, and the diseased tooth radicle was removed. Culture of the pus grew haemolytic staphylococcus aureus. In forty-eight hours the swelling diminished; the eyelids were still very oedematous. Temperature became normal, and forty-eight hours later the swelling practically disappeared though it recurred slightly round the eye two days later, and a course of 20,000 units of penicillin was again given for forty-eight hours. The baby was discharged from hospital seventeen days from the date of admission; he was clinically well. (See Plate III.)

Case 5. A female baby, aged fifteen weeks, had previously been well and, fed on a milk and water mixture, had reached the weight of 14 lb. 5 oz. A few days after the baby had had a 'cold' some swelling of the left face and eye was noticed.

EXAMINATION. A well-nourished infant, with obvious proptosis of the left eye and gross oedema spreading down to the lower part of the face, had signs of bronchitis, a temperature of 103° F., a pulse rate of 160, and respiration rate 60. Osteomyelitis of the left maxilla was diagnosed.

TREATMENT. Penicillin, 10,000 units three-hourly intramuscularly, and sulphadiazine 0·5 g. six-hourly orally, were given on admission, and the general condition began to improve. After three days there was less oedema of the face, but a small incision was made in the nasal side of the maxilla and purulent fluid was evacuated. Radiographs showed that the ethmoids were dim. After eight days of treatment the temperature subsided and the swelling was much less. The baby's condition was poor, and there were frequent watery stools. Three days later vomiting occurred and became severe, and deterioration set in with rapid loss of weight. Signs of nasopharyngitis and otitis media appeared. Bilateral myringotomy was performed but no pus was obtained. Intravenous fluid supplements were given, and 50 c.cm. of fresh blood transfused. Unfortunately the 'gastro-enteritis' persisted. A few days later right mastoidectomy was performed under local anaesthesia. The general state deteriorated further and death occurred thirty days from the beginning of the illness. Post-mortem examination showed left mastoiditis and haemorrhage, and toxic fatty changes in the liver and myocardium.

Discussion

The bacteriology in these cases was essentially that of a haemolytic staphylococcus aureus. An infected tooth radicle was removed in two cases, and it was in this infected radicle that the infection presumably started, having been carried there probably by the blood stream, as suggested by Jacoby and Sagorin (1945).

With the exception of one case (which was complicated by mastoid infection and a generalized toxaemia giving rise to enteritis and fatty changes in the liver and heart, and which eventually proved fatal) the infection was essentially a local one and was effectively cured by chemotherapy and a minimum of surgery to create free drainage.

In view of the known susceptibility of infants of this age to develop gastro-enteritis in conjunction with parenteral infections, it is interesting that in all the cases excepting the fifth there was no diarrhoea or vomiting. This bears out the impression that the most obvious and frankly purulent infections in infancy, such as osteomyelitis, empyema, etc., do not tend to give rise to such severe alimentary disturbances as the more concealed neonatal infections of the middle ears, sinuses, mastoid antra, and umbilicus.

I am indebted to the Physicians and Surgeons of the Children's Hospital, Birmingham, for permission to publish these cases, and to Dr. A. V. Neale and Mr. Stirk Adams who have kindly reviewed this paper.

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BRITISH PAEDIATRIC ASSOCIATION

PROCEEDINGS OF THE EIGHTEENTH GENERAL MEETING

The Eighteenth Annual Meeting of the British Paediatric Association was held at Windermere on April 25 and 26, 1947.

Business proceedings: The President, Prof. C. W. Vining, was in the Chair and the following members were present:

Drs. F. M. B. Allen, H. T. Ashby, C. Asher, F. Braid, J. V. Braithwaite, R. W. Brookfield, W. Brown, D. J. Browne, W. H. P. Cant, N. B. Capon, C. Chisholm, W. R. F. Collis, T. Colver, B. Corner, J. Craig, W. S. Craig, J. Crooks, G. Davison, R. H. Dobbs, E. Dott, R. W. B. Ellis, P. R. Evans, T. Y. Finlay, G. B. Fleming, F. J. Ford, A. W. Franklin, W. F. Gaisford, I. Gordon, S. Graham, C. K. J. Hamilton, J. D. Hay, J. L. Henderson, D. V. Hubble, J. H. Hutchison, R. S. Illingworth, N. M. Jacoby, H. E. Jones, C. P. Lapage, R. C. Lightwood, A. MacGregor, H. M. M. Mackay, C. McNeil, A. G. Maitland-Jones, R. Marshall, F. J. W. Miller, A. Moncrieff, A. E. Naish, A. V. Neale, G. H. Newns, D. N. Nicholson, A. G. Ogilvie, J. N. O'Reilly, L. G. Parsons, D. Paterson, W. W. Payne, C. P. Pinckney, C. J. Potter, B. Schlesinger, W. P. H. Sheldon, J. M. Smellie, J. F. Smith, R. E. Smith, J. C. Spence, R. E. Steen, K. Tallerman, M. L. Thomson, C. W. Vining, H. L. Wallace, H. Waller, J. F. Ward, A. G. Watkins, K. D. Wilkinson, T. P. Williams, M. J. Wilmers, W. G. Wyllie.

There were also thirty guests, including Dr. Howard Williams of Melbourne.

The MINUTES of the last Annual General Meeting were approved.

ELECTION OF OFFICERS: The following were unanimously elected by ballot for the year 1947-48:

PRESIDENT: Dr. Donald Paterson, London.

TREASURER: Dr. R. C. Lightwood, London.

SECRETARY: Prof. Alan Moncrieff, London.

EXECUTIVE COMMITTEE (to replace those retiring or resigning):

REPRESENTATIVES FOR LONDON:

Dr. P. R. Evans.

Dr. K. Tallerman.

ELECTION OF NEW MEMBERS: The following were elected by ballot to membership of the Association:

(a) HONORARY MEMBERS:

Mr. T. T. Higgins, F.R.C.S., London.

Sir Eardley Holland, London.

Prof. N. Morris, Glasgow.

Prof. C. W. Vining, Leeds.

Dr. H. Waller, London.

(b) CORRESPONDING MEMBERS:

Dr. Lorimer Dods (Sydney, Australia).

Dr. H. F. Helmholz (Rochester, U.S.A.)

(c) ORDINARY MEMBERS:

Dr. T. Colver, Sheffield.

Dr. E. Dott, Edinburgh.

Dr. A. C. Doyne Bell, London.

Prof. R. S. Illingworth, Sheffield.

Dr. C. G. Parsons, Birmingham.

The TREASURER'S REPORT was received and approved.

The SECRETARY'S REPORT was received and approved and is printed below.

NEXT PLACE OF MEETING: It was decided to hold next year's meeting at Windermere.

Secretary's Report on Activities of the Executive Committee

(AUGUST, 1946 to APRIL, 1947)

Mr. President, Ladies and Gentlemen,

This report covers less than a year, and since the last General Meeting, held in Rugby in August, 1946, the Executive Committee has met on four occasions. In addition to many routine matters of administration the following subjects have received the special attention of the Committee or are of sufficient general interest to be brought to the knowledge of the Association as a whole:

1. MINISTRY OF HEALTH: In the report of the Chief Medical Officer of the Ministry of Health 'On the State of the Public Health During Six Years of War' a special reference is made (p. 7) to the work of the Association. Dr. Dorothy Taylor has been appointed as an observer at meetings of the Executive Committee in place of Prof. W. S. Craig.

2. APPOINTMENTS AND DISTINCTIONS: Members will be pleased to learn that Prof. G. B. Fleming has been elected President of the Royal Faculty of Physicians and Surgeons of Glasgow; Prof. C. W. Vining has been made 'Professor Emeritus' in Leeds; and the Association will also wish to congratulate the following on their election to University Chairs: Dr. R. W. B. Ellis (Edinburgh), Dr. R. S. Illingworth (Sheffield), and Dr. J. M. Smellie (Birmingham).

3. PAEDIATRIC COMMITTEE OF THE ROYAL COLLEGE OF PHYSICIANS: The final report of this Committee was issued in October, 1946, and a copy was sent to all members who had not already received it as Fellows. The report has been widely circulated and is likely to have considerable influence upon the development of the child health services of the future. Already advertisements have appeared

for the posts of 'Child Health Officers,' a term used in the report, for the West Riding of Yorkshire. In connexion with another county council appointment, a paediatrician for Kent, the Association was asked to send an assessor. Two assessors were also appointed from the Association for the appointment of an assistant physician in the Children's Department at the London Hospital.

4. ADVERTISEMENTS AND VACANCIES : At each meeting the Executive Committee receives a report on paediatric vacancies advertised since the last meeting and on the action taken to inform the appointing body of the Association's 'Suggestions for the Appointment of a Consultant Paediatrician.' Correspondence on this subject is often extensive, but it has resulted in some instances in considerable modification of conditions and of salaries offered.

5. HOSPITAL AND CHILD HEALTH PLANNING : During the year several requests for help were received on matters of detail referred to individual members of the Association, and in reference to plans for Cheshire County Council a sub-committee visited the district in February, 1947, afterwards preparing a report which has been approved by the Executive Committee.

6. REGIONAL PAEDIATRIC PLANNING : With the setting up of Regional Boards the necessity for active planning of the paediatric services of a region will become urgent. The Executive Committee feels that the B.P.A. should play a prominent part in such planning and is prepared to consider how it can help by the nomination of members to serve on appropriate committees and by exchange of information between regions.

7. INTERNATIONAL MEETINGS : The Executive Committee has given considerable attention to securing representation at the International Paediatric Congress to be held in New York in July, 1947, and it is hoped that Sir Leonard Parsons, and Drs. Ellis, Paterson, Maitland-Jones, Hutchison, Moncrieff, and Potter may be present, as well as several non-members. An International Conference of Physicians to be held in London in September, 1947, is having a Paediatric Section, of which Sir Leonard Parsons is Chairman and Dr. R. C. Lightwood Secretary. The Executive Committee was asked to submit suggestions for the invitation of visitors and on subjects for discussion.

8. SUB-COMMITTEES AND REPRESENTATIVES. The joint sub-committee with the Royal College of Obstetricians on neonatal mortality has completed its report, which, it is hoped, will be published as an official document. The Tuberculosis Sub-Committee has prepared a memorandum in reply to a request from the National Association for the Prevention of Tuberculosis on the subject of 'preventoria.' The joint sub-committee on convalescent homes has met on several occasions during the year, and the present position is that the King Edward's Hospital Fund is bringing out a list of convalescent homes in its own area and has asked the Association to provide a list of London members prepared to visit and report on convalescent homes. The joint sub-committee with the Association of Sick Children's Hospital Nurses has met to discuss the training of male nurses in children's wards, and the giving of some experience to general nurses in the care of children. A resolution has been sent to the General Nursing Council and to the Ministry of Health expressing alarm at the decrease in the number of beds available for the training of the sick children's nurse. On the Consultant Services Committee Dr. Paterson has continued to represent the Association; and for this Committee, in connexion with the new Spens Committee on the remuneration of consultants and specialists, the Executive Committee nominated Prof. Spence as a member and prepared evidence on the remuneration of paediatricians. Dr. W. G. Wyllie has been appointed to represent the Association on a new organization called 'The British Association for the Welfare of Spastics.'

9. ARCHIVES OF DISEASE IN CHILDHOOD : The Executive is recommending that Dr. P. R. Evans be appointed joint editor with Prof. R. W. B. Ellis. For 1947 Dr. P. R. Evans and Dr. S. Graham were appointed to the Editorial Committee in place of Dr. H. C. Cameron and Prof. G. B. Fleming. For 1948 the Executive is recommending Prof. R. S. Illingworth and Prof. J. M. Smellie as members of the Editorial Committee in place of Dr. P. R. Evans and Dr. D. Paterson. These appointments are made jointly by the B.M.A. and the B.P.A.

10. OBITUARY. Members will learn with regret of the death of Dr. A. Hayes Smith of Bradford, a member since 1932.

11. SWISS PAEDIATRIC ASSOCIATION : A cordial invitation was once again received from the Swiss Paediatric Society to send a delegate to their annual meeting, and for any member of the B.P.A. to attend who wished to do so.

12. ANNUAL MEETING AND MEMBERSHIP : Arrangements have now been made whereby the annual meeting can be held in Windermere at a fixed date each year, namely just before the third week-end after Easter. The Executive Committee proposes to review the whole question of membership during the coming year, in order that the subject may be fully ventilated at the Annual Meeting in 1948.

13. RESIGNATION OF HON. TREASURER : The Executive Committee learned with considerable regret that Dr. Donald Paterson was retiring to live in Canada. The Association was largely launched and sustained by his energies, and the Executive hopes to bring forward in due course some plans for permanently linking his name with some activity of the Association.

ALAN MONCRIEFF.

Communications

1. DR. R. E. BONHAM-CARTER (London) (introduced by Prof. A. Moncrieff): 'A Preliminary Study of the Morbid Histology of the Liver in Fatal

Cases of Diarrhoea and Vomiting in Infants'. Twenty-four fatal cases of this condition formed the material; twelve had parenteral infections proved at autopsy, twelve had not. Slides of liver tissue showed three kinds of change: fatty change and fibrosis, both starting in the portal areas, and miliary necrosis. The fatty change was divided into three degrees: slight, in the portal areas only; marked, when some normal liver tissue could be seen; gross, when no normal liver tissue could be seen (see table).

Days ill	Fatty change			Fibrosis	Necrosis	Total
	Slight	Marked	Gross			
1–7	3(2)*	1	1	0	1(1)†	6†
8–14	1(1)	6(4)	1(1)	5(4)	5(4)	8
15–28	1	0	6(3)	6(2)	6(2)	7
29+	2	0	1(1)	3(1)	2(1)	3

* ( ) Brackets show number of cases with parenteral infection.
† One case with no fatty change, but with B. coli pyelitis.

As this group was not made up of consecutive cases no deduction can be made about the frequency of these changes, but it has been shown that not only does the fatty change occur, but also fibrosis and miliary necrosis in fatal cases of this condition. The similarity to the changes described in the liver of the deprived experimental animal, and in the malnourished human infant, was noted. The many influences which may adversely affect the liver cell were emphasized, and no attempt was made to attribute these changes to any specific cause. The possible relationship of the fatty change to fibrosis, and the probable effect of the duration of the illness was pointed out. Six histological slides were shown.

2. Dr. S. A. Doxiadis (Newcastle-on-Tyne) (introduced by Prof. J. C. Spence): 'Azotaemia in Dehydration in Infancy.' Forty-two cases of extrarenal azotaemia in infancy have been studied in order to define the conditions under which this azotaemia may develop. Dehydration of any or all the compartments of body fluids was the determining factor. The cause of the dehydration was, in most but not in all cases, diarrhoea and vomiting of various etiology. Infection without dehydration does not produce azotaemia, but it may contribute to it either by causing the dehydration or by increasing tissue protein breakdown and consequently the amount of urea formed in the body. Extrarenal azotaemia is much more common in the first three months of life, and this age incidence is due to the well-known fact that the younger infants become more easily dehydrated. Continuous rise in blood urea in spite of relief of the haemo-concentration indicates a dehydration nephrosis and carries a bad prognosis.

3. Dr. G. Donaldson (London) (introduced by Dr. W. W. Payne): 'Potassium in Diarrhoea and Vomiting.' Following the work of Darrow and others, a preliminary investigation has been carried out at the Hospital for Sick Children, Great Ormond Street, London, on serum potassium levels in infants suffering from gastro-enteritis. The work was based on the thesis that abnormal loss of fluid and electrolyte from the body may cause such alteration in intracellular chemistry that without specific therapy recovery may not occur. Although serum potassium does not necessarily reflect the intracellular potassium, it was thought that in prolonged cases of gastro-enteritis some parallelism might exist. Serum potassium estimations were carried out in twenty cases. Blood samples were taken on admission, after hydration, and during the course of the illness. A range of 15-26 mg. per cent. was found in the majority of infants. Some high figures were found in the acutely dehydrated infants. Low figures, i.e. below 14 mg. per cent. were found in five cases, in all of which gastro-enteritis was prolonged and there was considerable tissue wasting. In all the cases with low serum potassium clinical improvement occurred when intravenous and oral potassium chloride was given.

4. Dr. Ursula James (London) (introduced by Dr. H. Mackay): 'An Epidemic of B. proteus Enteritis in a Children's Hospital.' An outbreak of gastro-enteritis associated with B. proteus vulgaris occurred in a Children's Hospital. There were two carriers in the wards at the time, one a child with osteomyelitis with B. proteus in the discharge from the sinuses, and the other a persistent urinary infection with the same organism.

Eleven infants all under nine months old admitted for various reasons, feeding difficulties, pulmonary infections, etc., developed gastro-enteritis with B. proteus in the stools. The stools had been negative on admission to hospital and became positive on the day the diarrhoea started. There were four deaths. The cases were all severe, diarrhoea predominating over the vomiting; the stools were large, pale, and fluid, with blood in a few cases, and the diarrhoea persisted over an average period of four weeks. Abdominal distension was marked. The liver was enlarged in eight cases, and five became jaundiced between the tenth and fourteenth days. Three of these infants had bile in the urine, and two developed purpura. Otitis media occurred in seven cases, and five of these developed bilateral mastoiditis which was treated surgically. Two cases came to autopsy and had extensive ulceration in the large and small intestines. The livers were enlarged, pale, and greasy, but no sections were taken. The epidemic was only stopped by closing the wards in turn and limiting admissions to children of nine months and over until all cases of B. proteus infection had left the hospital.

Records of B. proteus enteritis in infants are made by Konsek (*Monat. Kind.*, **88**, 69), and by Neterer and Farrer (*Amer. J. digest. Dis.*, 1943, 10, 344). Experimentally, B. proteus endotoxin has been shown to produce periportal necrosis with oedema.

It seems that this series of gastro-enteritis cases was caused by the B. proteus infection, perhaps

aggravated by a parenteral infection, and that the liver damage was due to the endotoxin of the B. proteus. If this is so, methionine might be given with advantage in the early stage of the illness.

5. Dr. M. Bodian (London) (introduced by Dr. W. Sheldon): 'Pulmonary Haemosiderosis.' Twelve cases have been reported in the literature, and seven more are reported now. All but one occurred in childhood. Sudden dramatic attacks of dyspnoea, cyanosis, cough, and fever, followed by anaemia and jaundice, give the clinical picture. Physical signs in the chest are minimal. During attacks, the right heart dilates and liver and spleen enlarge. Gross radiological changes in the chest simulate chronic miliary tuberculosis or congestive heart failure. The heart is normal between attacks. Hypochromic anaemia with certain haemolytic features can be explained by recurrent haemorrhages into the lungs. The pathology is entirely confined to the lesser circulation. Lungs are rubbery, large, and reddish-brown, with pneumonic patches and haemorrhages. The heart is only slightly enlarged. Alveoli are crowded with, and lined by, haemosiderin-laden histiocytes. There is marked pulmonary interstitial fibrosis and notable degeneration, fragmentation, and reduplication of elastic fibres in alveolar walls and small and medium sized pulmonary vessels. These fibres are coated with iron pigment. The etiology is unknown. Heart and blood changes are secondary to those in lungs. Degeneration of elastic fibres may be primary, and haemorrhages, haemosiderosis, and fibrosis secondary; or fibrosis of lungs may lead to rupture of elastic tissue, and haemorrhages and haemosiderosis may follow.

6. Dr. J. M. Naish (Bristol) (introduced by Prof. C. B. Perry): 'Harrison's Sulcus.' The eponym, Harrison's sulcus, has been wrongly attributed to Edward Harrison (1766-1838). The sulcus was in fact described by Edwin Harrison (1789-1847) as a means for determining the position of the diaphragm.

Examination of five hundred Bristol schoolchildren between the ages of five and thirteen years showed that a sulcus of measurable depth was present in 45·6 per cent. Deeper sulci (over ¼ in.) occurred in 2·4 per cent. There was no difference in the sex or age incidence. One hundred children with asthma, twenty-five with a history of rickets in infancy, and thirty-five with congenital heart disease, were also examined. Sulci were found with significant frequency in children with pigeon chests, with a history of asthma or pneumonia, or of impoverished parents. The early nutritional history had no bearing on the development of sulci. In the sample studied, sulci occurred more frequently in children with past rickets, congenital heart disease, or a history of bronchitis or measles in infancy, but these findings, though suggestive, were not significant. But, since sulci occurred with significant frequency in the severer grades of congenital heart disease, the finding of indrawing of the intercostal spaces in infants with such disease may prove to be a useful diagnostic and prognostic sign.

For obvious anatomical reasons the sulci cannot be caused directly by the pull of the diaphragm.

7. Dr. E. Allibone (Birmingham) (introduced by Prof. C. W. Vining): 'The Inter-renal Syndrome in Childhood.' From a review of the case material of the Birmingham Children's Hospital during the last ten years, ten cases of adrenal hyperplasia in the new born were described, and the symptomatology and diagnosis discussed. The persistence of urinary chloride as a diagnostic aid was pointed out.

The adrenogenital syndrome in older children was represented by three cases, all due to hyperplasia. One boy presented the typical picture of macrogenitosomia praecox. The two girls were both pseudohermaphrodites. One was thought to be a boy, the other, though reared as a girl, had masculine features, figure, and personality.

Two girls with adrenocortical obesity, or Cushing's syndrome due to adrenal carcinoma, were described.

An attempt was made to correlate the two syndromes with histological changes in the adrenal cortex. Although the proportion of transient to permanent cortex was variable in adrenal hyperplasia in the new born, the transient cortex predominated in the adrenogenital syndrome in older children but was completely absent in the atrophic contralateral adrenal to the carcinoma in Cushing's syndrome. Fuchsinophil material, when present, was predominantly in the transient cortex and was probably concerned with the production of androgens, whereas the cytoplasm of the permanent cortex was mainly vacuolated and presumably concerned with adrenocortical hormone production.

8. Dr. Mildred Creak (London) (introduced by Dr. W. G. Wyllie): 'The Intelligence Quotient in Cases of Rhesus Incompatibility.' From a group of seventy-nine cases of erythrocytosis foetalis sixty-five survived. A preliminary report of intelligence tests on forty-three of these, an unselected sample, is submitted. Twenty-four were girls, and nineteen were boys, the ages ranging from fourteen months to four years eight months. Test procedure included an interview with the mother, and an assessment of the developmental quotient (D.Q.) using Gesell's Scale and Norms. An intelligence test (I.Q.) was given to children of eighteen months or over. Tests used were the Merrill-Palmer Scale and Terman-Merrill revision of Stanford-Binet.

Distribution of I.Qs.

Below 70	4	children
70- 90	3	,,
90-110	23	,,
110-120	9	,,
Over 120	4	,,

Five children had gross neurological involvement consonant with kernicterus and showing choreoathetosis, extra-pyramidal rigidity, inco-ordination,

and major and minor seizures. All five had low D.Q. and I.Q. The neonatal illness in each case included both jaundice and anaemia; in only one was there severe and persistent haemolysis.

Only two other children had slightly lowered I.Q and D.Q., with accompanying rickets. Seven others with normal I.Q. and D.Q. showed slight physical anomalies not suggestive of kernicterus; two of these had respectively the most severe and the most prolonged icterus of the total group.

These results suggest that severe mental defect is closely associated with neurological damage, and that without such damage mentality is likely to be within normal limits.

9. MRS. HUMPHRIES and MISS POYNER WALL (Birmingham) (introduced by Prof. J. Smellie): 'Protein Supplements in the Feeding of Premature Infants.' The value of high protein feeding for premature infants was discussed. Assuming that the ideal rate and quality of growth is that which would have occurred in utero, the protein requirements were estimated to be about 2 g. per lb. per day.

A series of cases was reported in which up to 2·2 per cent. casein hydrolysate was added to supplement the protein of breast milk or evaporated milk mixtures. Alternate infants were used as controls and given equicaloric feeds without the protein supplement but with extra sugar. Observations of weight, haemoglobin, and serum proteins levels were made. No difference was found in the rate of gain in weight, nor in haemoglobin levels. A definite relationship, however, was shown between the serum protein levels and dietary intake of protein. The serum protein levels of the infants on high protein feeds were maintained at about 5 g. per 100 c.cm., whereas the levels in the controls showed a fall which was maximal between the third and eighth weeks. At twelve weeks, when the protein intake in both series was similar, there was little difference in the serum protein levels. A few cases showed that the high protein feed was unable to maintain the serum protein levels at 5 g. per 100 c.cm. when the calorie intake was inadequate.

No conclusions could be drawn with regard to the clinical significance of the serum protein levels in this series, but attention was drawn to recent experimental work in animals, relating dietary protein and serum levels with antibody production.

10. DR. H. W. DALTON (Manchester) (introduced by Dr. M. L. Thomson): 'Treatment of Coeliac Disease with Folic Acid.' Two cases were described in detail. Before treatment there was steatorrhoea, a 'flat' glucose tolerance curve, a megaloblastic bone marrow, some evidence of a 'deficiency bowel pattern,' and no flushing after 50 mg. of nicotinic acid. When given 5 mg. of folic acid daily with ferric et ammon. cit., 20 gr., and mist. F.A.C. with an ordinary diet, together with supplements of ascorbic acid and Vitamins A and D, both children had a reticulocyte response of over 25 per cent. with great clinical improvement. After the blood counts had reached approximately normal levels, it was found that the steatorrhoea, flat glucose tolerance curve, deficiency bowel pattern, and lack of response to a test dose of nicotinic acid were still present. The clinical improvement has been maintained for the past three months on a 'maintenance' dose of folic acid, 5 mg. twice weekly. In one of these cases examination of the peripheral blood did not suggest that a megaloblastic anaemia was present; the other had high colour index.

In seven other cases the marrow was normoblastic; three of these showed some macrocytosis. In two cases a normal glucose tolerance test and faecal fat analysis have been found after treatment with folic acid for five weeks. Results in the other cases are pending.

11. DR. E. F. DOTT (Edinburgh) (introduced by Prof. R. W. B. Ellis): 'Nocturnal Enuresis.' In functional nocturnal enuresis, as seen in children of school age, there is a well established disorder of the control of micturition. Despite dutiful, and perhaps frequent, voluntary micturition in waking hours, these children have a constant residue of urine in the bladder. In early years, the child has consistently overdistended the bladder by delaying micturition until the need is urgent. In course of time this gives rise to what may be termed 'the three inabilities of the enuretic.' (1) His overstretched bladder cannot empty itself in the time normally given to micturition. (2) He cannot appreciate the presence of urine in the bladder until too much has collected. (3) He finds it difficult to initiate micturition except under stress of overdistension. These three inabilities frustrate well intentioned efforts at dutiful behaviour. They perpetuate the disorder, which thus outlives its original causes. Careful explanations and a period of training will cure the condition in most children over five years old who co-operate.

The explanations, to child and parent, must be lucid; the directions exact. These directions include two essentials. (1) The child must pass urine at regular intervals of time, chosen to anticipate his feeling of need; for this, in the enuretic, comes too late. (2) He must completely empty the bladder on each occasion. This, for him, is a new accomplishment and needs practice.

The method gives excellent results, particularly in those over five who wish to improve and are intelligent; that is to say, in the large majority of cases where medical advice is sought. Of 282 cases reviewed, 173 (61 per cent.) were cured; seventy (25 per cent.) were improved; and thirty-nine (14 per cent.) showed no change.

An AFTER-DINNER DISCUSSION on 'The Teaching of Paediatrics' was opened by Prof. N. B. Capon (Liverpool).

The Third George Frederic Still Memorial Lecture on 'Some Clinical Aspects of Lactation' was delivered by Dr. H. Waller (London) on Saturday, April 26, 1947

REVIEWS

Researches on Pre-Natal Life. By SIR JOSEPH BARCROFT, Fellow of King's College, Cambridge, and Director of the Unit of Animal Physiology, Agricultural Research Council. Vol. I. 1946. Oxford: Blackwell Scientific Publications. Pp. 292. (Price 37*s.* 6*d.*)

The author described this volume as of the nature of a will, and, although he lived to see it published his many friends and admirers will regret how nearly the description was justified. The aim of the book is to trace the development of function of the mammalian foetus, and it is essentially based on work which, over a period of many years, the author had himself carried out or for which he had been largely responsible. This in itself makes the book a fascinating synthesis, since it illustrates how planned experiment in a particular field can build up a monument of knowledge from its foundations. As originally designed, the work was divided into two volumes; the first of these deals with the function of the placenta, growth of the foetus, and the possible influence on this of diet, the volume and distribution of blood in the foetal circulation, oxygen consumption, and pre-natal and neonatal respiration. (In the second volume it was intended to deal with the nervous system and metabolic problems.)

The particular interest of this book to the paediatrician will be obvious. To take only two examples: the effect of maternal malnutrition on the foetus, and the physiology of respiration at birth, are both questions of first importance in relation to neonatal mortality, and ones on which the experimental approach can give practical help to the clinician. There is good evidence, for instance, that in the sheep the size of the foetus at birth can be materially reduced by severe restriction of maternal diet and it is interesting to find that Dr. Clement A. Smith's investigations in Holland (*J. Pediat.*, 1947, **30**, 229) showed that the birth weight, and to a less extent the birth length, of infants also were reduced by maternal deprivation during the last half or last trimester of pregnancy. Similarly Barcroft's observations on the mechanism of respiration at birth, though made in the first instance on lambs, can be utilized in formulating a rational method of resuscitating the human infant.

The publishers have produced a volume which it is a pleasure to read, and which gives cause for optimism regarding the possible standard of post-war book production.

The 1946 Year Book of Pediatrics. Edited by Isaac A. Abt, D.Sc., M.D., with the Collaboration of Arthur F. Abt, M.D. 1946. Chicago: The Year Book Publishers. Pp. 464. (Price 21*s.*)

This book is one of the familiar scissors-and-paste variety, which nevertheless has a certain value to the harassed paediatrician attempting to keep abreast of the literature. A large number of papers are somewhat uncritically abstracted, and the publishers have brightened the dust-cover with a quiz, to which the page-numbers of the answers are attached.

Child Health. Edited by ALAN MONCRIEFF, M.D., F.R.C.P., Nuffield Professor of Child Health, University of London, and WILLIAM A. R. THOMSON, M.D. 1947. London: The Practitioner Handbooks. Eyre and Spottiswoode. Pp. 254. (Price 14*s.*)

Some twenty-two articles on Child Health, which have appeared in the *Practitioner* and have been subsequently revised, make up this useful addition to the well-known series of Practitioner Handbooks. Sir Leonard Parsons contributes an introduction on child health and the general practitioner, and other subjects included are child welfare centres, day nurseries and nursery schools, the school health services and special schools, child guidance clinics, care of the newborn, care of deaf, blind, crippled, rheumatic and tuberculous children, and control of the common fevers of childhood. Four articles are devoted to nutrition or infant feeding. A fair distribution of subject matter between the clinical and social aspects of child health has been made. It is appropriate that the last of the Practitioner handbooks to be edited by Professor Moncrieff should be devoted to child health, and we wish it an even wider popularity than its predecessors.

The Psychology of the Unwanted Child. By AGATHA H. BOWLEY, Ph.D., The School Psychological Service, Leicester. 1947. Edinburgh: E. and S. Livingstone. Pp. 108. (Price 6*s.*)

Dr. Bowley has succeeded in writing a sensible guide to the psychology and handling of the underprivileged child, in language which should be quite comprehensible to the intelligent lay reader for which it is primarily intended. The Curtis Committee Report has made it abundantly clear that there is a need for a book of this type, and this is one which can be recommended.

A Handbook on Diseases of Children. By BRUCE WILLIAMSON, M.D., F.R.C.P., Physician, Children's Department, Royal Northern Hospital, etc. Fifth Edition. 1947. Edinburgh: E. and S. Livingstone. Pp. 408. (Price 15*s.*)

This book is already well known and deservedly popular. In view of the introduction of penicillin, the fifth edition has been extensively revised, although it is only two years since the fourth edition was published. The production and illustration are for the most part excellent, though it might have been wiser to adopt a consistent policy in

reproducing radiographs as either positives or negatives.

Diseases of the Nervous System: Described for Practitioners and Students. By F. M. R. WALSHE, M.D., D.Sc., F.R.C.P., F.R.S. Fifth Edition. 1947. Edinburgh: E. and S. Livingstone. Pp. 351. (Price 16*s.*)

Nutritional Disorders of the Nervous System. By JOHN D. SPILLANE, B.Sc., M.D., M.R.C.P. 1947. Edinburgh: E. and S. Livingstone. Pp. 280. (Price 20*s.*)

Though both excellent of their kind, these two books are alike in paying such scant attention to nervous disorders in childhood that the general reader can hardly be said to get a balanced view of the subject as a whole. For example, in the section on chronic subdural haematoma, Dr. Walshe does not mention birth injury as a possible cause, nor consider the diagnosis in infancy. Dr. Spillane has produced a valuable and interesting study of nutritional diseases of the nervous system, largely based on war experience. Here again, children have provided much clinical material which the author has only briefly mentioned. It is to be hoped that in future editions more detailed consideration may be given to the manifestations and diagnosis of such conditions as pellagra and beri-beri in infancy and early childhood.

The following books and journals have also been received:

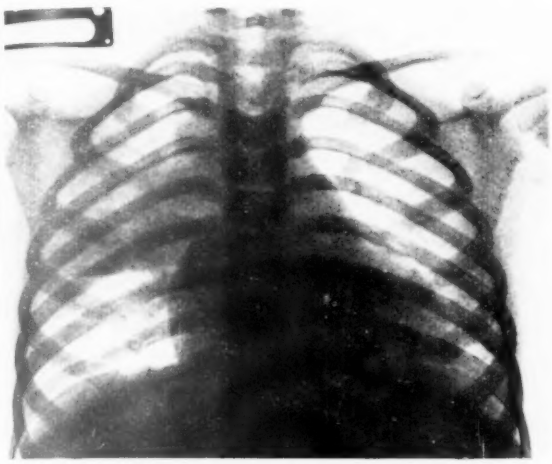
Nutritional and Vitamin Therapy in General Practice. By EDGAR S. GORDON, M.D., Ph.D., Associate Professor of Medicine, University of Wisconsin. Third Edition. 1947. Chicago: The Year Book Publishers Inc. Pp. 410. (Price 27*s.* 6*d.*)

Child Health and Development. Edited by RICHARD W. B. ELLIS, O.B.E., M.D., F.R.C.P., Professor of Child Life and Health, University of Edinburgh. 1947. London: J. and A. Churchill. Pp. 364. (Price 18*s.*)

Medical Disorders of the Locomotor System including the Rheumatic Diseases. By ERNEST FLETCHER, M.A., M.D., M.R.C.P., Physician to the Arthritis Clinic and Lecturer on the Rheumatic Diseases, Royal Free Hospital, etc. 1947. Edinburgh: E. and S. Livingstone. Pp. 625. (Price 45*s.*)

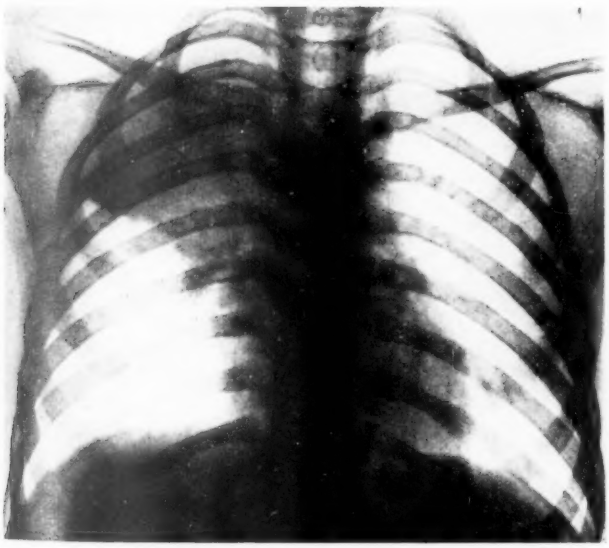
Il Lattante (monthly). Tipografia Donati, Parma.

Paediatria Danubiana (monthly). International Journal of Paediatrics. Athenaeum Publications, Rakoczi-ut 54, Budapest VII.



(a).—Showing collapse of right upper lobe (case 2).

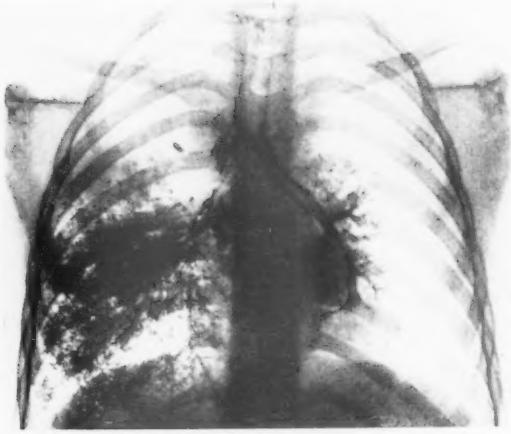
(b).—Showing block of right upper-lobe bronchus (case 2).



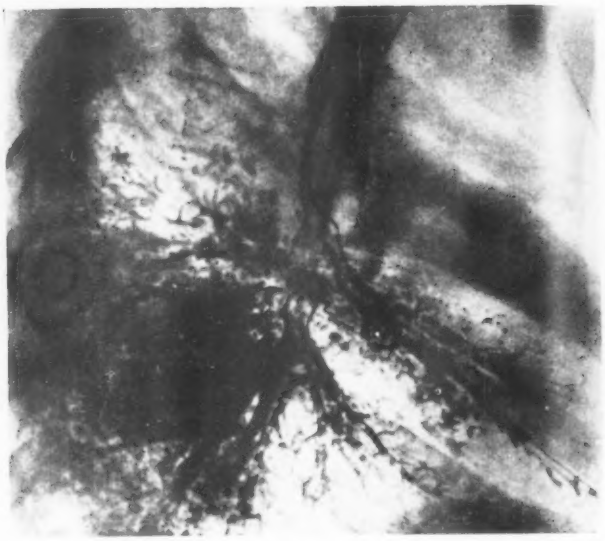
(c).—Antero-posterior view showing collapse of right upper lobe and obstructive emphysema of right lower lobe (case 4).

(d).—Right lateral view showing 'gull-wing' lower border of completely collapsed right upper lobe (case 4).

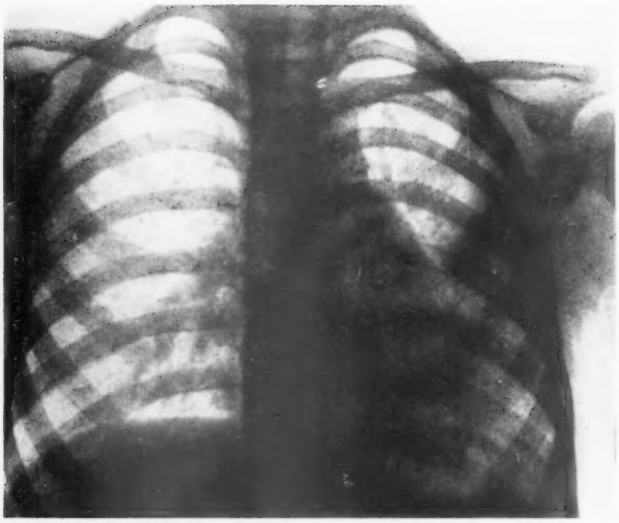
PLATE I.



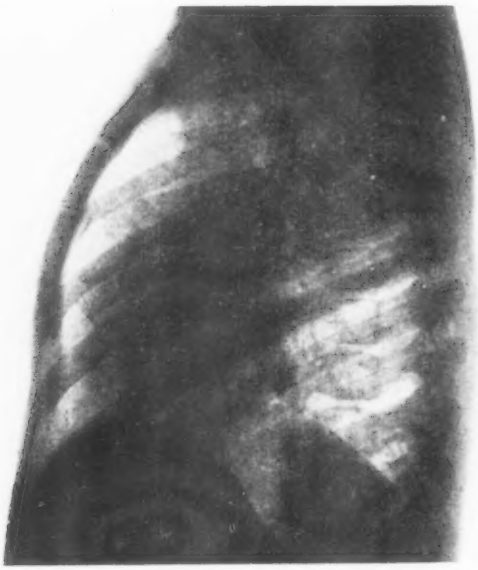
(e).—Showing complete occlusion of right upper-lobe bronchus (case 4).



(f).—Right lateral view showing marked constriction of the right main bronchus (case 4).

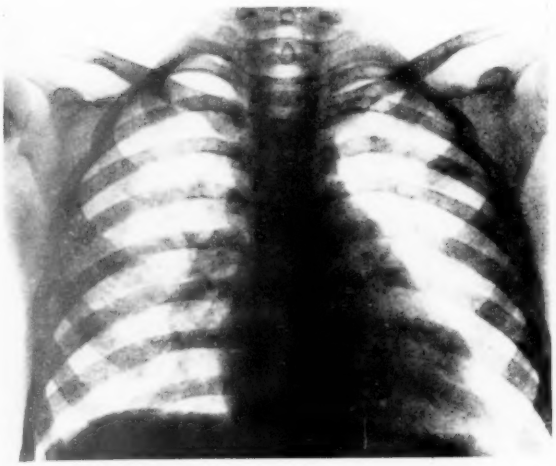


(g).—Antero-posterior view showing collapse of left lower lobe with mediastinal shift to the left (case 6).



(h).—Left lateral view showing collapse of the left lower lobe (case 6).

PLATE II.



(j).—Antero-posterior view showing obstructive emphysema of the left lower lobe, with return of mediastinium to the normal position (case 6).

(k).—Showing cylindrical bronchiectasis of the left lower lobe, with narrowing of the left main bronchus (case 6).

OSTEOMYELITIS OF THE MAXILLA IN INFANCY BY J. C. HAWORTH

(a).—Case 4. Condition on admission to hospital.

(b).—Case 4. Condition on discharge from hospital.

PLATE III

(1a)

(1b)

FIG. 1.—Case 1, M. M. Photographs taken on tenth day, showing the comparatively small area involved, although she was critically ill from fluid loss in the first thirty-six hours.

(2a)

FIG. 3.—Case, 15, M. S. Extensive fourth- and fifth-degree burns. No resuscitation. Death six and a half hours after accident.

(3a)

(3b)

(2b)

FIG. 2.—Case 3, L. D. Second- and third-degree scalds over a comparatively small area. This child was also critically ill from fluid loss during the first twenty-four hours. (See text, p. 134.)

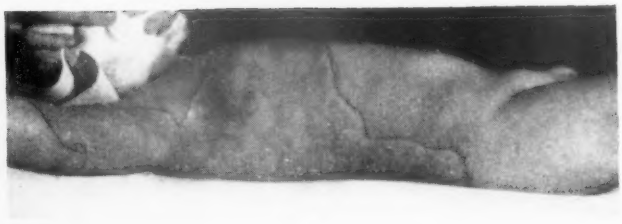
(a) (b)

FIG. 4, a and b.—Case 26, N. B. Extensive fourth- and fifth-degree burns. No resuscitation. Death six hours after accident.

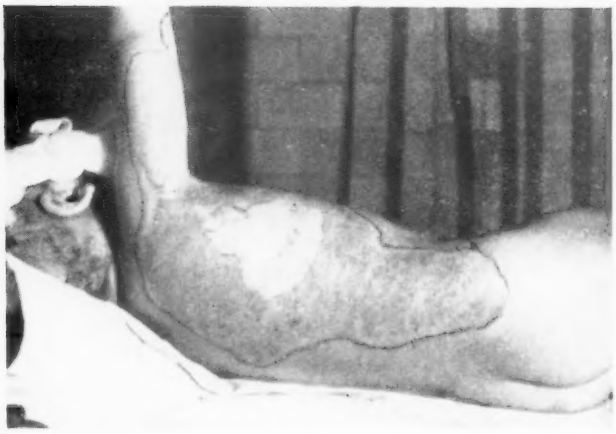
(a) (b) (c)

FIG. 5.—Case 28, M. W. Extensive fourth- and fifth- degree burns, (a) day of admission, and (b and c) three and a half months later, showing complete healing after repeated Tiersche grafting (the whole area sloughed).

PLATE V



(6a)



(6b)

FIG. 6.—Case 29, A. P. Scalds caused by boiling water, showing central sloughing on sixth day.

(7)

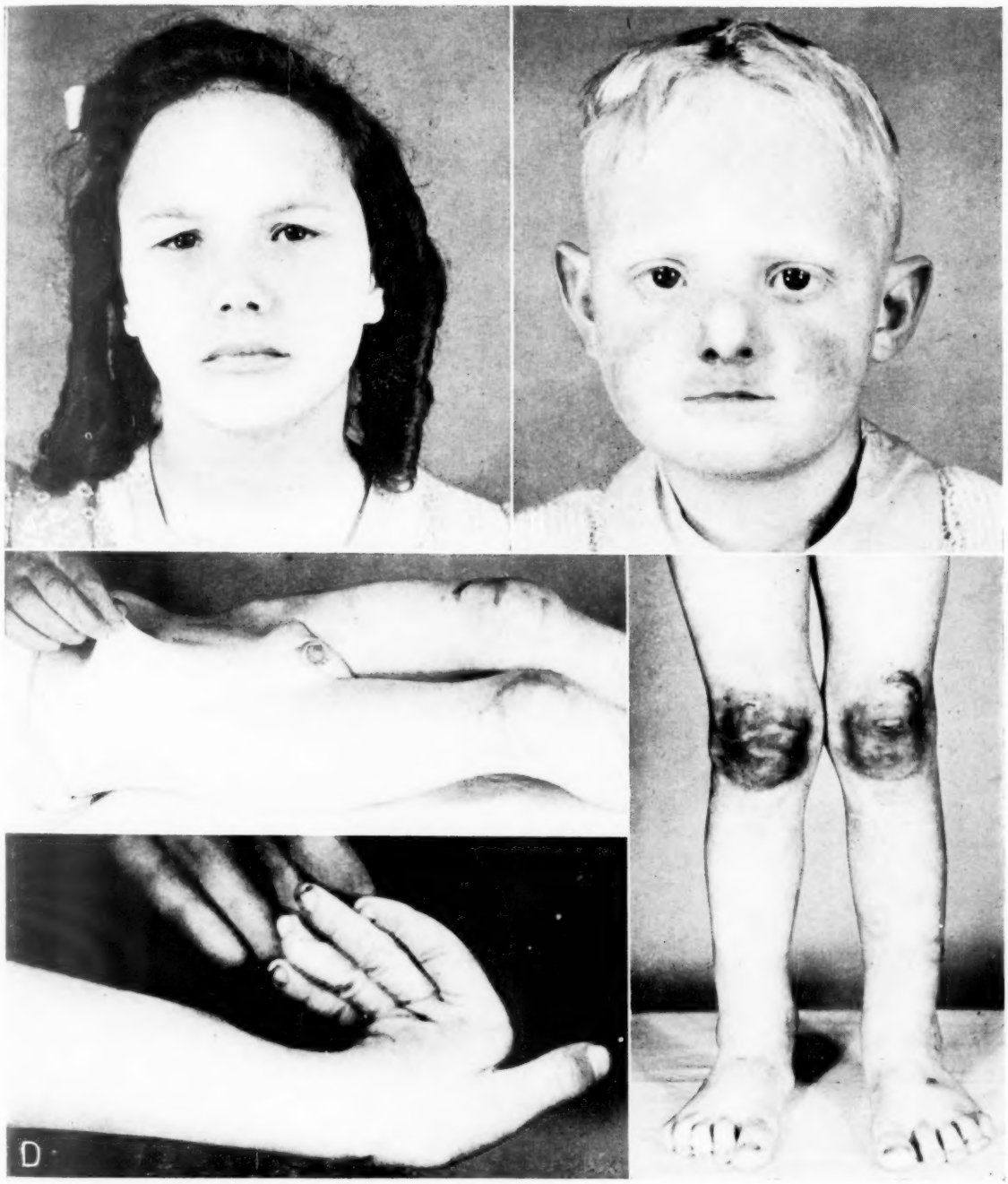
FIG. 7.—Case 30, C. R. Extensive deep scalds photographed on the fifth day. The entire area sloughed and required grafting. The child was very ill but ultimately made a complete recovery. (See also figs. 11 and 12.)

(8a)

(8b)

FIG. 8.—Case 31, E. L. Fourth-degree burns. Appearance a few hours after the accident—white with some brown charred cuticle. Complete sloughing and successful skin grafting subsequently.

PLATE VI



(A) Case 2, showing exaggeration of the inner canthus; (B to E) Case 1, showing (B) exaggeration of the inner canthus and scarring of the nose and forehead, (C) loose and hyperelastic skin, and scarring of the knees, (D) hyperextensibility of joints, (E) typical thin, papyraceous, and atrophic scarring of knees, and multiple bruises on legs.

PLATE VII

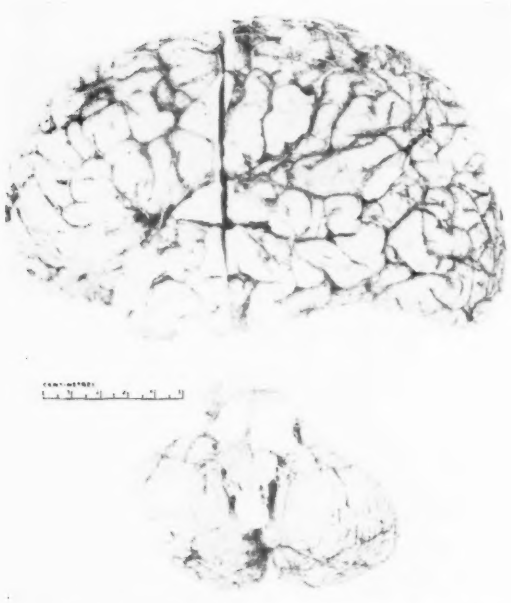


FIG. 1.—Brain of Janet G., age one year. Generalized enlargement. (Weight, 1,450 g.)

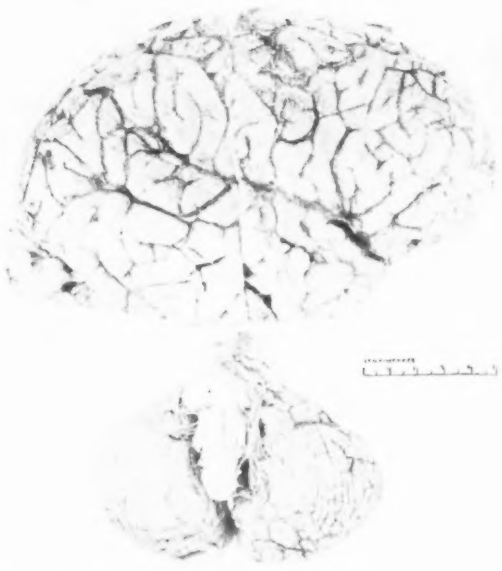


FIG. 2.—Brain of Linda B., age fifteen months. Generalized enlargement and flattening of convolutions. (Weight, 1,770 g.)

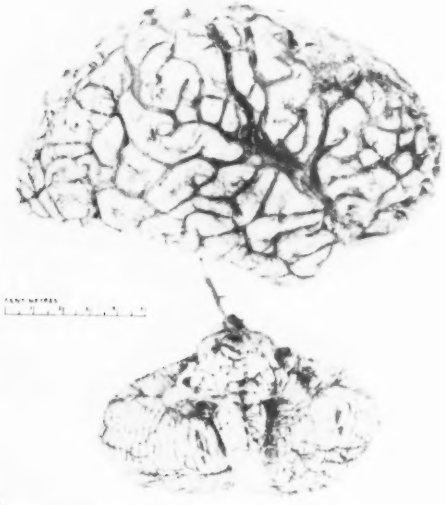


FIG. 3.—A normal adult female brain. (Weight, 1,300 g.)

PLATE VIII